

SCHOOL OF CIVIL ENGINEERING



JOINT HIGHWAY RESEARCH PROJECT

FHWA/IN/JHRP-81/10

EVALUATION OF DESIGN AND CONTROL
ALTERNATIVES TO IMPROVE SAFETY
OF INTERSECTIONS OF MULTI-LANE
HIGHWAYS WITH OTHER HIGHWAYS

H.L. Michael

K.C. Sinha

J.A. Fletcher



PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

Final Report

EVALUATION OF DESIGN AND CONTROL ALTERNATIVES TO IMPROVE SAFETY OF
INTERSECTIONS OF MULTI-LANE HIGHWAYS WITH OTHER HIGHWAYS

TO: R. L. Eskew, Chairman
Joint Highway Research Project

FROM: H. L. Michael, Director
Joint Highway Research Project

July 1, 1981
Revised Dec. 28, 1981
Project: C-36-59X
File: 8-5-24

Attached is the Final Report on the HPR Part II Study "Evaluation of Design and Control Alternatives to Improve Safety of Intersections of Multi-Lane Highways with Other Highways".

This Report briefly summarizes the significant results reported in earlier Interim Reports, presents the results of application of the simulation program developed in this study using countermeasures of likely value at the 18 high accident intersections provided for study by ISHC, and provides an analysis of the accidents and causation factors of the accidents at these intersections. Finally the countermeasures most likely to be of greatest benefit in reducing accidents as determined from all phases of this study are evaluated and the most beneficial and practical are recommended for implementation.

The high accident intersection analyses are reported individually with each one complete as they are highly individualistic.

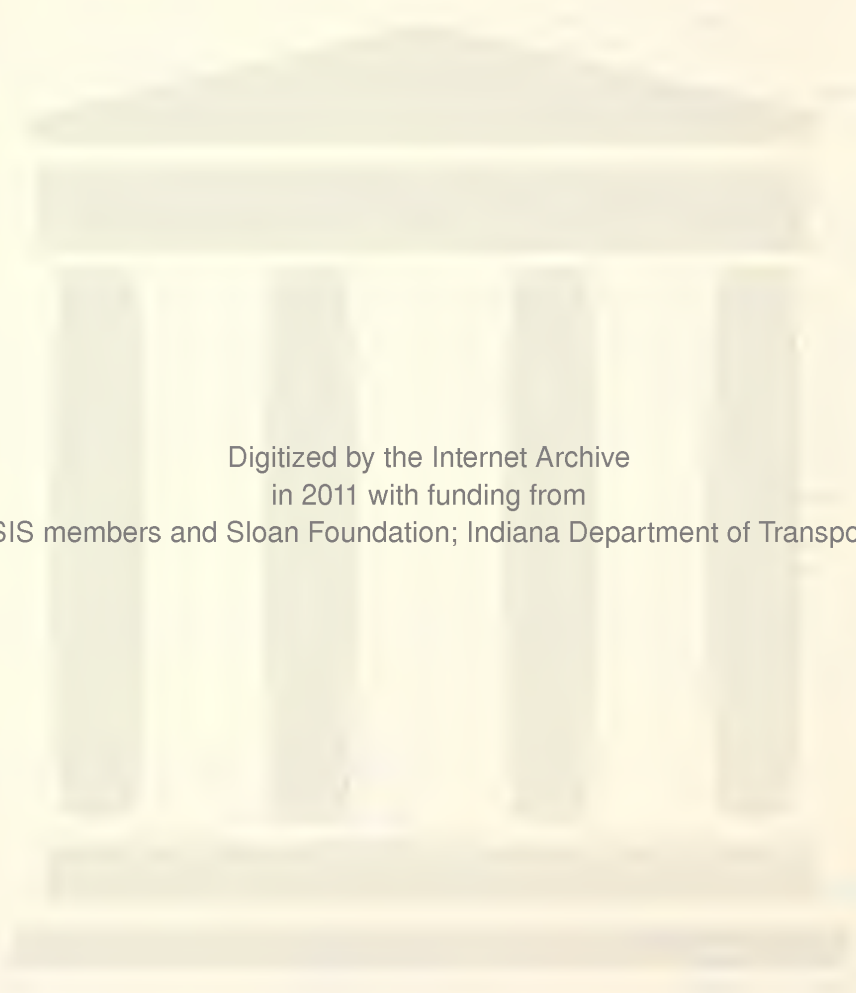
This Report is submitted for acceptance as completion of all the requirements of this Study. With its acceptance and publication-distribution, the study will terminate.

Sincerely,

Harold L. Michael /ms
Harold L. Michael
Director

HLM:ms

cc: A. G. Altschaeffl	G. K. Hallock	C. F. Scholer
W. L. Dolch	D. E. Hancher	R. M. Shanteau
R. L. Eskew	K. R. Hoover	K. C. Sinha
J. D. Fricker	J. F. McLaughlin	C. A. Venable
G. D. Gibson	R. D. Miles	L. E. Wood
W. H. Goetz	P. L. Owens	E. J. Yoder
M. J. Gutzwiller	G. T. Satterly	S. R. Yoder



Digitized by the Internet Archive
in 2011 with funding from
LYRASIS members and Sloan Foundation; Indiana Department of Transportation

Final Report

EVALUATION OF DESIGN AND CONTROL ALTERNATIVES TO
IMPROVE SAFETY OF INTERSECTIONS OF MULTI-LANE
HIGHWAYS WITH OTHER HIGHWAYS

by

Harold L. Michael
Director

Kumares C. Sinha
Research Engineer

and

Joseph A. Fletcher
Research Engineer

Joint Highway Research Project

Project No.: C-36-59X

File No.: 8-5-24

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Purdue University
West Lafayette, Indiana
July 1, 1981
Revised Dec. 28, 1981

1. Report No. FHWA/IN/JHRP-81/10	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle EVALUATION OF DESIGN AND CONTROL ALTERNATIVES TO IMPROVE SAFETY OF INTERSECTIONS OF MULTI-LANE HIGHWAYS WITH OTHER HIGHWAYS		5. Report Date July 1, 1981 Revised Dec. 28, 1981	
		6. Performing Organization Code	
7. Author(s) H. L. Michael, K. C. Sinha, J. A. Fletcher		8. Performing Organization Report No. JHRP-81-10	
9. Performing Organization Name and Address Joint Highway Research Project Civil Engineering Building Purdue University West Lafayette, Indiana 47907		10. Work Unit No.	
		11. Contract or Grant No. HPR-1(18) Part II	
12. Sponsoring Agency Name and Address Indiana State Highway Commission State Office Building 100 North Senate Avenue Indianapolis, Indiana 46204		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes Conducted in cooperation with the U.S. Dept. of Transportation, Federal Highway Administration. Research study titled "Evaluation of Design and Control Alternatives to Improve Safety of Intersections of Multi-Lane Highways with Other Highways".			
16. Abstract The important results of earlier phases of this research - 1) correlation of accident rates and selected roadway design and traffic engineering factors; 2) utilization of a team approach to field evaluation of accident types, causal factors and countermeasures at high accident sites and 3) the use of a simulation program to analyze possible countermeasures for high accident locations - are summarized in this report. In addition 18 high accident intersections in Indiana selected by the Indiana State Highway Commission are individually analyzed using the results of the earlier phases of this Study, and recommended countermeasures for reduction of the accidents at these sites are presented.			
17. Key Words Intersection safety; accidents; accident causal factors; accident countermeasures; high accident sites		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 223	22. Price

TABLE OF CONTENTS

<u>Item</u>	<u>Page</u>
INTRODUCTION.	1
ANALYSIS OF THE HIGH ACCIDENT INTERSECTION.	4
*SITE NO. 1, S.R. 63 and S.R. 163 Intersection.	6
*SITE NO. 2, S.R. 37 and S.R. 450 Intersection.	18
*SITE NO. 3, U.S. 24 Bypass and S.R. 5 Intersection	30
*SITE NO. 4, U.S. 31 and S.R. 18 Intersection	43
*SITE NO. 5, S.R. 37 and S.R. 48 Intersection	56
*SITE NO. 6, South Junction of S.R. 39 and S.R. 67.	69
*SITE NO. 7, S.R. 37 and S.R. 252 Intersection.	81
*SITE NO. 8, U.S. 31 and S.R. 14 Intersection	93
*SITE NO. 9, U.S. 41 and 45th Avenue Intersection	105
*SITE NO. 10, U.S. 31 and Kern Road Intersection.	117
*SITE NO. 11, U.S. 31 and S.R. 38 Intersection.	129
*SITE NO. 12, U.S. 40 and Round Barn Road Intersection. . . .	141
*SITE NO. 13, U.S. 31 and National Avenue Intersection. . . .	153
*SITE NO. 14, S.R. 67 and Franklin Road Intersection.	165
*SITE NO. 15E, Northeast Junction of S.R. 67 and I-465, East Intersection.	177
*SITE NO. 15W, Northeast Junction of S.R. 67 and I-465, West Intersection.	189
*SITE NO. 16E, Southwest Junction of S.R. 67 and I-465, East Intersection.	201
*SITE NO. 16W, Southwest Junction of S.R. 67 and I-465, West Intersection.	213
SUMMARY	224
BIBLIOGRAPHY.	226
Table 1. List of Designated High Accident Locations.	2
Figure 1. Geographical Location of Designated High Accident Locations	3

*Each intersection site report typically contains five (5) Figures (Condition Diagram, Volume Diagram, 3 Collision Diagrams-1974, 1975, 1975) and four (4) Tables (3 Accident Summaries-1974,1975, 1976 and a Table of Possible Benefits from Simulation Analyses of Pertinent Countermeasures). Where these Figures or Tables are not included their absence is explained.

INTRODUCTION

This report is a summary of the results of a three phase research project undertaken to evaluate high accident intersections in Indiana. The first phase of the research was conducted by Peter A. Van Maren (3) and consisted of a regression analysis between accident rates and selected roadway design and traffic engineering factors. Highlights of the significant findings from this research were:

1. For unsignalized intersections with stop control on the minor roadway, the factors most highly correlated with accident rates are the danger distance, or distance across the intersection; the presence of a median barrier; and the size of the stop sign.
2. For high accident signalized intersections, the factors most highly correlated with accident rates are the absence of stop lines, the absence of advance warning signs, the presence of horizontal curves, and intersection skew.

The second phase of the research was undertaken by James R. Ogren (1) and involved a team approach to the evaluation of high accident intersections. Traffic engineers from the Indiana State Highway Commission selected sixteen sites involving eighteen intersections for analysis. The selected sites are listed in Table 1, and shown in their geographical locations in Figure 1.

Results of the second phase of the research project included selection of the size, professional disciplines and organization of the evaluation teams, a procedure manual to guide the team members in their field evaluations of the intersections, selection of the field data to be supplied to each team member, and procedures to obtain a team consensus regarding accident types, causal factors, and countermeasures.

Table 1

List of Designated High Accident Locations

<u>Site No.</u>	<u>Location</u>	<u>County</u>	<u>ISHC District</u>
1	SR 63 at SR 163	Vermillion	Crawfordsville
2	SR 37 at SR 450	Lawrence	Vincennes
3	US 24 By-pass at SR 5	Huntington	Fort Wayne
4	US 31 at SR 18	Miami	Fort Wayne
5	SR 37 at SR 48	Monroe	Seymour
6	SR 39 at SR 67(S.Jct.)	Morgan	Seymour
7	SR 37 at SR 252	Morgan	Seymour
8	US 31 at SR 14	Fulton	LaPorte
9	US 41 at 45th Ave.	Lake	LaPorte
10	US 31 at Kern Rd.	St. Joseph	LaPorte
11	US 31 at SR 38	Hamilton	Greenfield
12	US 40 at Round Barn Rd.	Wayne	Greenfield
13	US 31 at National Ave.	Marion	Greenfield
14	SR 67 at Franklin Rd.	Marion	Greenfield
15	SR 67 at I-465(2)(NE)	Marion	Greenfield
16	SR 67 at I-465(2)(SW)	Marion	Greenfield

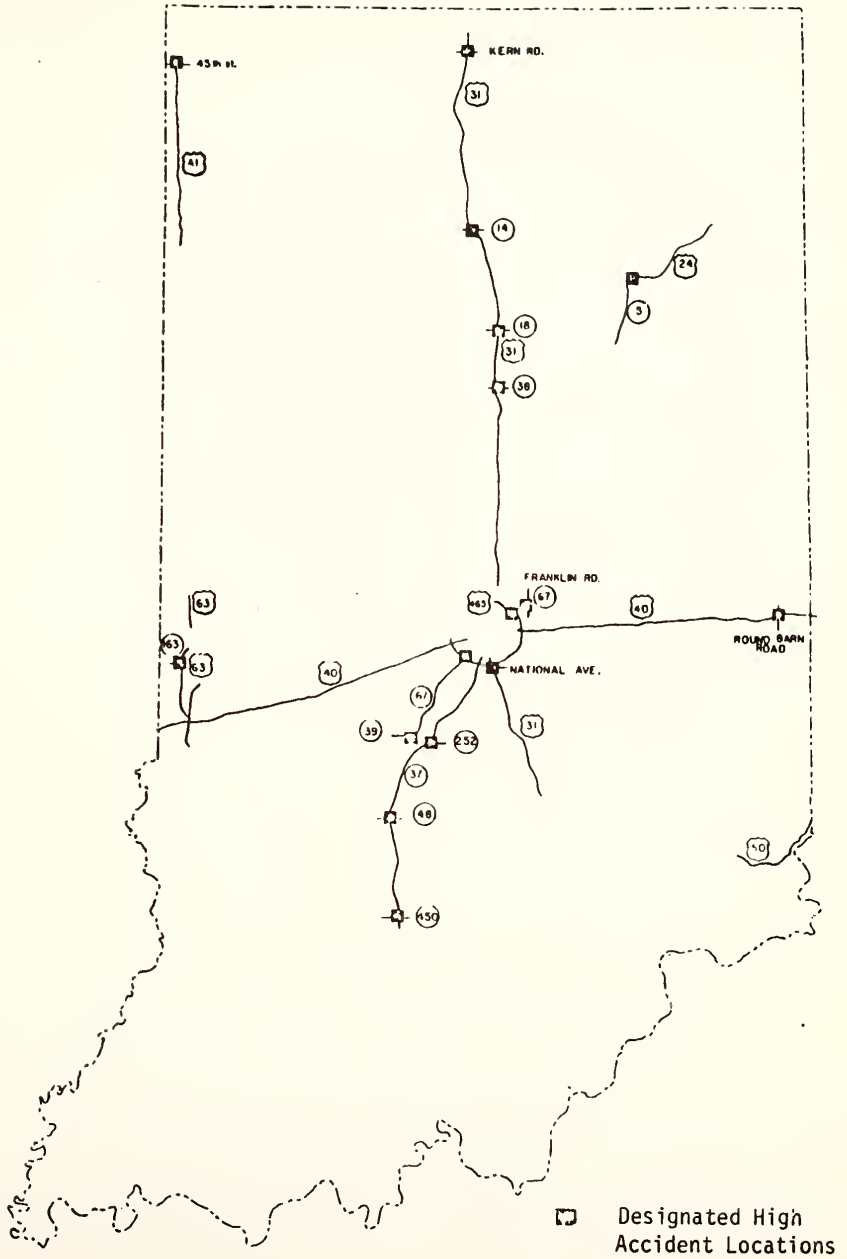


Figure 1. Geographical Location of Designated High Accident Locations

Later sections of this report will be devoted to a detailed analysis of each of the eighteen high accident intersections with recommendations for countermeasures.

The third phase of the research was conducted by Ahmed E. Radwan (2), and consisted of analysis of selected countermeasures for high accident intersections using a computer simulation package. Significant findings from the simulation study are summarized below:

1. For stop-controlled divided intersections:
 - a. The number of conflicts decreased significantly with an increase in median width.
 - b. A steep downgrade on the side street approach caused significantly more conflicts than an upgrade.
 - c. A median stop sign caused significantly fewer conflicts than a median yield sign.
 - d. Advance warning systems significantly reduced the number of conflicts.
2. For signalized intersections:
 - a. Fully actuated signals caused fewer conflicts than fixed-time or semi-actuated signal systems.
 - b. Addition of separate left turn phases reduced the number of left-turn conflicts, but increased the average delay.
 - c. Addition of an all-red phase reduced the number of conflicts.

ANALYSIS OF THE HIGH-ACCIDENT INTERSECTIONS

As noted, an interdisciplinary team evaluated each of the eighteen intersections as reported by Ogren (1). That report included the findings of the team for five of the intersections but did not report the findings at the remaining thirteen. It also did not provide any recommendations

relative to the priority of improvements found to be of possible benefit at these intersections. The primary purpose of this Final Report for this Study is to report the findings of the interdisciplinary team at each of the eighteen intersections, to apply the earlier findings of what operational and design factors impact on accident rates, to apply the computer model adopted in this study to each intersection using the possible effective countermeasures developed in the three phases of the research, and provide recommendations for each intersection as to the countermeasures most likely to be practical of accomplishment and to have the greatest benefit.

Thirteen of the intersections analyzed in succeeding sections of this report were evaluated without a meeting of the evaluation team to develop a team consensus. The results and conclusions drawn were determined from analysis of the written comments of the individual team members. The analyses of five intersections (Sites 1, 9, 11, 13 and 14) were obtained from team meetings at which the final consensus was determined. The results of these meetings were previously published by Ogren (1).

For ease of reference and possible use of the information each of the eighteen intersections is presented separately and completely as a section of this report. They are presented in order by the site number given in Table 1. Intersections numbered 15 and 16 actually are two intersections each (interchange off-ramp intersections of an interstate highway with a cross-road) and are reported separately. For each intersection, pertinent Tables and Figures are included.

SITE NO. 1

S.R. 63 and S.R. 163 Intersection

Description of S.R. 63 and S.R. 163 Intersection

The intersection of S.R. 63 and S.R. 163 is in Vermillion County in the Crawfordsville District of the Indiana State Highway Commission. It is located in a rural area approximately one mile west of Clinton, Indiana. S.R. 63 is a four-lane divided highway with left and right turn lanes at the intersection. S.R. 163 is a two-lane highway. The intersection is controlled by flashers, with a stop sign on S.R. 163 and yield signs in the median for S.R. 163 traffic.

The traffic volumes are relatively light at this intersection, with S.R. 63 carrying approximately 1800 vehicles per day in each direction, and S.R. 163 approximately 1200 vehicles per day in each direction.

There have been a total of 22 accidents at this intersection during the study period, with 13 injuries and 3 fatalities.

Evaluation of the Intersection

This intersection was discussed at a meeting of the Independent team. The result of this meeting was a team consensus. The causal factors listed below are ranked in order of importance and the countermeasures are not rank-ordered.

Predominant Accident Type - Right Angle

Primary Cause - Poor visibility of flashers on S.R. 63.

Countermeasures - Increase the wattage of the lamps in the flashers, relocate the flashers to the lane lines, install another flasher focusing farther down the highway.

Other Possible Causes - Inadequate warning to S.R. 163 traffic, confusion on the part of left-turning vehicles.

Other Possible Countermeasures - Install auxiliary sign on S.R. 163 indicating multilane flow, install oversize advance warning signs, build left-turn slots through the median so left-turning traffic is not opposing.

Other Accident Types

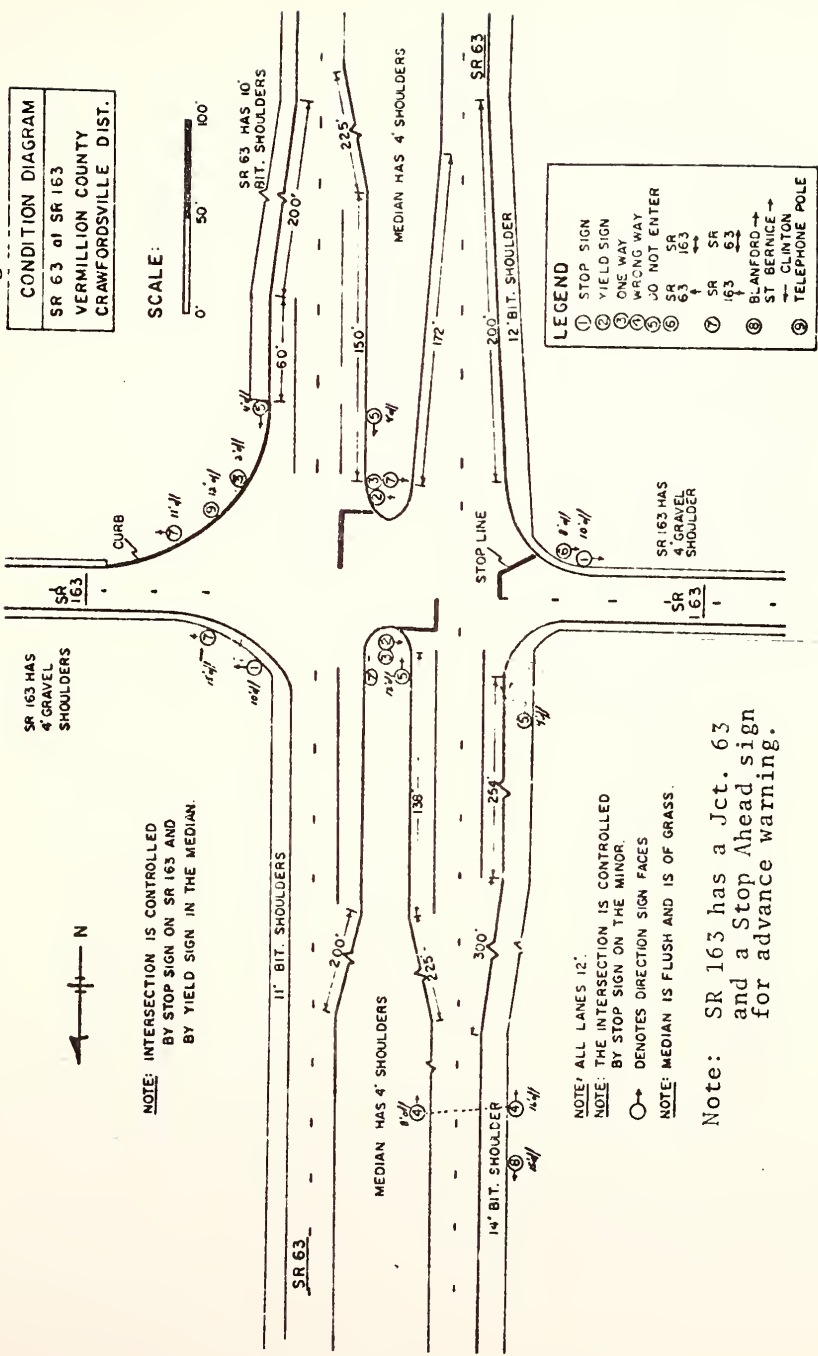
The other accident types were insignificant at this intersection.

The statistical correlation work done by Van Maren (3) did not include analysis of additional flashers. However, two countermeasures were evaluated with the computer simulation model. Two countermeasures, evaluated by applying the simulation model, included the installation of an advance warning system at 1000 ft. and at 2000 ft. from the intersection. The results indicated no reduction of the number of conflicts in all categories (see Table 1-4).

Conclusion

The accident history at this intersection does not justify expensive reconstruction such as left-turn slots through the median. Our recommendations are to relocate the flashers over the lane lines and to increase the wattage in the bulbs.

Figure 1-1.



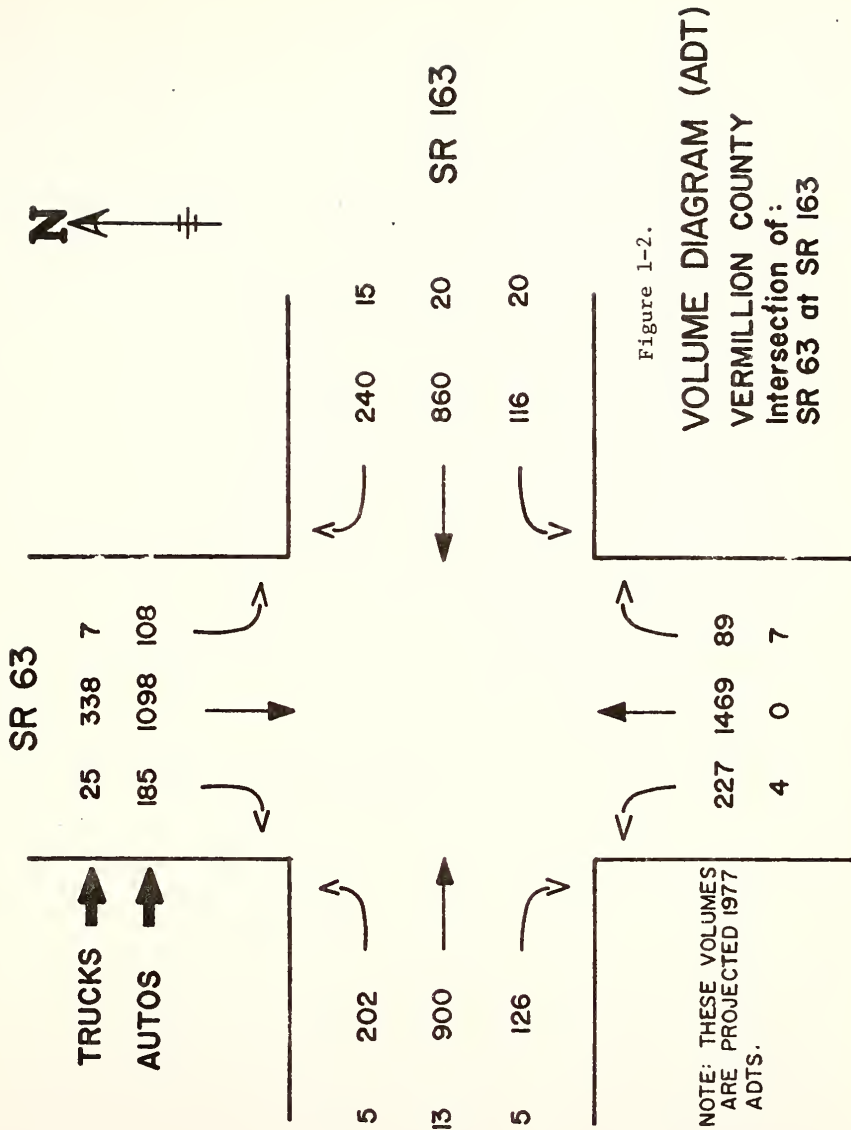


Table 1-1.

ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Crawfordsville

TOTAL ACCIDENTS	DAY	DARK
4	2	2

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
	3	1	2	3

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
	3		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
3	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1					1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM													0
PM		1		1		1				1			4

Table 1-2.

ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Crawfordsville

TOTAL ACCIDENTS		DAY		DARK	
7		6		1	

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
1	6		2	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
1	4		L= 1 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
7			

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	1		1	1		1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1									1		1	3
PM		1	1	1		1							4

Table 1-3.

ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Crawfordsville

TOTAL
ACCIDENTS

11

DAY

DARK

11

PERSONAL
INJURYPROPERTY
DAMAGE

FATAL

INJURED

KILLED

4

7

9

REAR END

RIGHT ANGLE

OUT OF
CONTROLTURNING
MOVEMENT

2

5

L= 4 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

WET

SNOW/ICE

OTHER

11

SUN.

MON.

TUES.

WED.

THUR.

FRI.

SAT.

1

2

3

2

3

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1		2		3	6
PM	1		1		1	2							5

Table 1-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at S.R. 63 at S.R. 163 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	0.62	2	22
Advance Warning (1000 feet)	0.66	2	27
Advance Warning (2000 feet)	0.86	3	22

SITE NO. 2

S.R. 37 and S.R. 450 Intersection

Description of S.R. 37 and S.R. 450 Intersection

The intersection of S.R. 37 and S.R. 450 is in Lawrence County in the Vincennes district of the Indiana State Highway Commission. S.R. 37 is a four-lane divided highway with left and right turn lanes at the intersection. The east leg of S.R. 450 is an undivided four-lane highway and the west leg is a two-lane facility. The intersection is controlled by an actuated traffic signal.

The traffic volume on S.R. 37 is approximately 5000-6000 vehicles per day in each direction. The traffic volume on the east leg of S.R. 450 is approximately 6500 vehicles per day, and that on the west leg of S.R. 450 is approximately 2400 vehicles per day. The turning movements at the intersection are quite heavy, especially onto and off of the east leg of S.R. 450.

The accident history at this intersection shows a total of 48 accidents in the study period, which consists of about 25 months after the opening of the S.R. 37 bypass. The accident total includes one fatality and 28 personal injuries.

Evaluation of the Intersection

The team consensus regarding accident type, causes and countermeasures at this intersection was, that because of the significant change in the accident history at this intersection for the two complete study years, no conclusions could be drawn. During the first full year of operation of the intersection there were 34 accidents, including one fatality and 20 personal injuries. Of the 34 accidents, 25 were right-angle collisions. The second year there were only 11 accidents, with eight injuries, and only three of those accidents were right-angle collisions. As noted above this history began shortly after opening of the S.R. 37 bypass and the first year's accidents may well reflect the new operational conditions at this location.

The computer simulation model was applied to compare the existing condition of the intersection with two possible countermeasures which included 1) an increase of left turn phase duration from 60 seconds to 72 seconds on the major road (S.R. 37) and 20 seconds to 36 seconds on the minor road (S.R. 450), and 2) a reduction in the speed limit of the major road (S.R. 37) from 55 mph to 45 mph. The results indicated no appreciable change in stop delay per vehicle or in the number of conflicts (see Table 2-4).

Conclusion

It is recommended that no action should be taken at this time, but that the accident records continue to be monitored, and if the future accident history warrants it the intersection should be restudied.

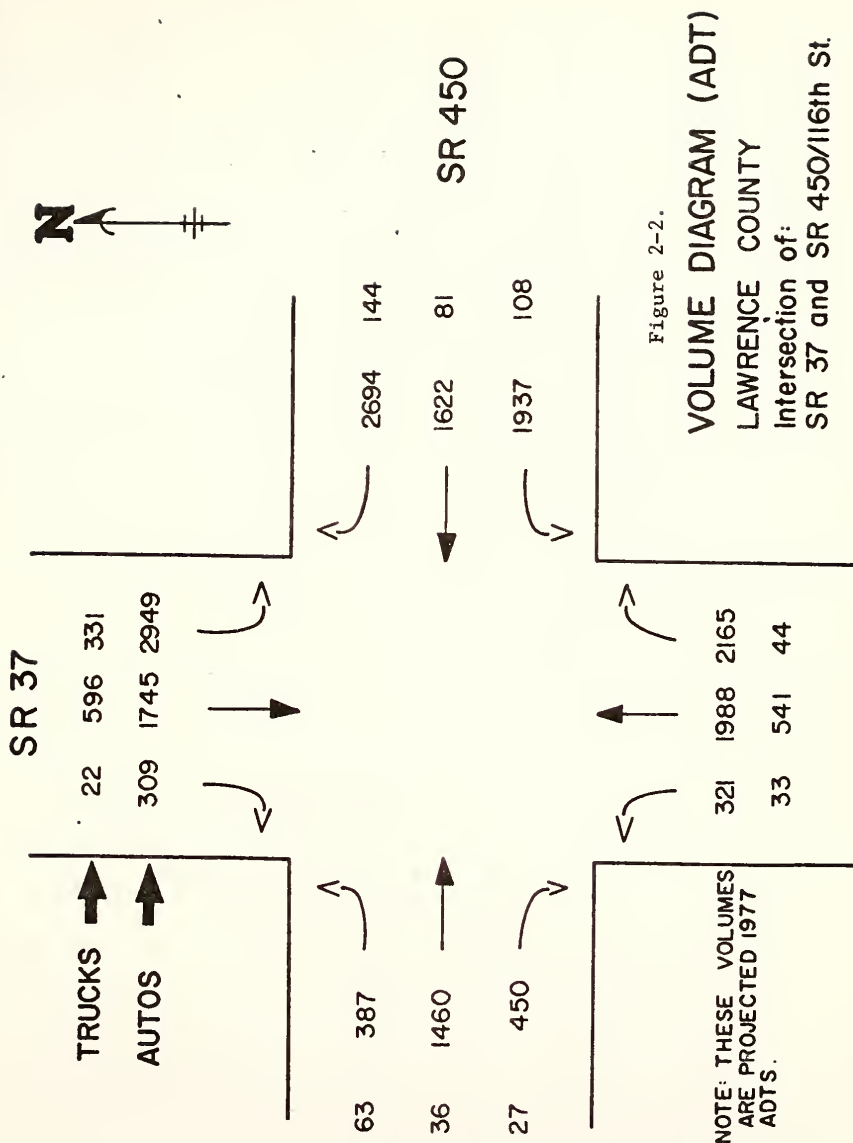


Figure 2-3.

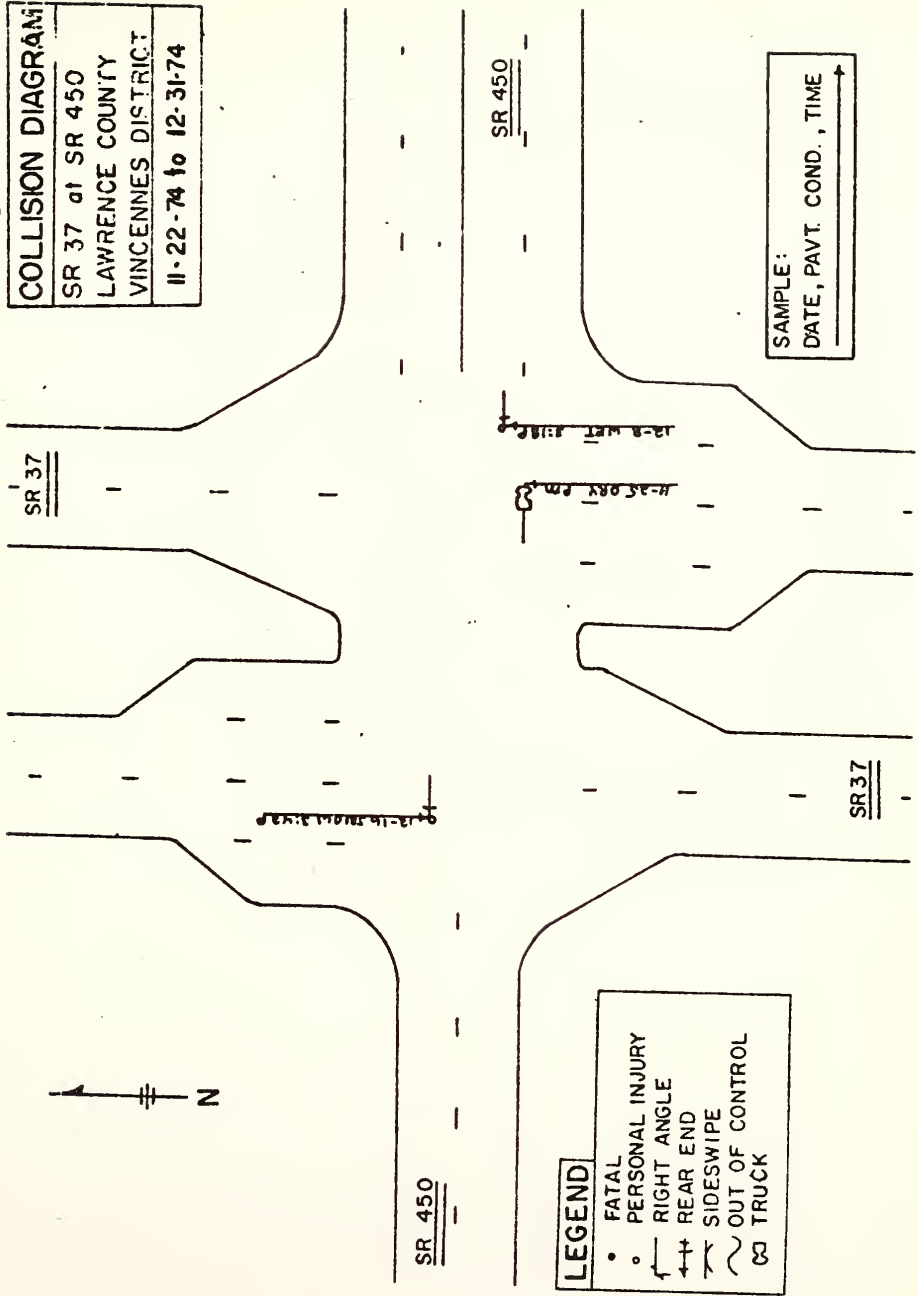


Table 2-2.

ACCIDENT

SUMMARY

LOCATION: SR 37 Bypass at SR 450/SR 158/16th St.

Lawrence County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Vincennes

TOTAL
ACCIDENTS

34

DAY

DARK

29

5

PERSONAL
INJURY

14

PROPERTY
DAMAGE

19

FATAL

1

INJURED

20

KILLED

1

REAR END

3

RIGHT ANGLE

25

OUT OF
CONTROL

1

TURNING
MOVEMENT

L= 3 R= 1

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

26

WET

5

SNOW/ICE

3

OTHER

SUN.

5

MON.

7

TUES.

3

WED.

3

THUR.

6

FRI.

7

SAT.

3

TIME FACTOR * 2 NOT GIVEN

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								2	1	1	3	1	8
PM	2	2	1	2	6	4	5	1	1				24

Table 2-3

ACCIDENT

SUMMARY

LOCATION: SR 37 Bypass at SR450/SR 158/16th St.

Lawrence County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Vincennes

TOTAL ACCIDENTS
11

DAY	DARK
9	2

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
5	6		8	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
2	2		L= 3 R= 1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
10		1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1	1	2	1	1	4	1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM										1	2		3
PM	1			3	1	1			1		1		8

Table 2-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at S.R. 37 - S.R. 450 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	22.22	21	64
Increase Left-Turn Phase Duration	17.39	19	72
Speed Enforcement on Major Road	17.17	23	67

SITE NO. 3

U.S. 24 Bypass and S.R. 5 Intersection

Description of U.S. 24 Bypass and S.R. 5 Intersection

The intersection of U.S. 24 Bypass and S.R. 5 is located in Huntington County in the Fort Wayne Indiana State Highway Commission district just outside of the city of Huntington, in a rural-suburban area. U.S. 24 Bypass is a four-lane divided highway with right and left turn bays at the intersection. S.R. 5 is a two-lane highway with right turn lanes controlled by "yield" signs at the intersection. The intersection is controlled by an actuated traffic signal.

Traffic volumes are relatively light on both highways, approximately 2000 to 4000 vehicles per day in each direction, but with heavy right turn movements onto eastbound U.S. 24 Bypass from northbound S.R. 5, and heavy left turn movements from westbound U.S. 24 Bypass to southbound S.R. 5.

The number of accidents at this intersection has not been great, totaling 18 for the three-year period under study, but these 18 accidents include one fatality and 16 personal injuries, indicating that the severity of the accidents is of concern.

Predominant Accident Type - Rearend

Primary Cause - Unexpected signal. The team members agreed that visibility at this intersection was good, but that because of its isolated location relative to other signals on U.S. 24 motorists were not expecting the signalized intersection and were travelling too fast to stop, either for the signal itself or because other vehicles were already stopped.

Consensus Countermeasure - Provide a high-type of advance warning signs on all approaches.

Other Possible Causes - Traffic signals obscured by overhead route signs, left-turn vehicles on U.S. 24 Bypass not in storage lanes, right-turn vehicles on S.R. 5 not in storage lanes, distracting environment due to excessive signage.

Other Possible Countermeasures - Relocate overhead route signs, lengthen U.S. 24 Bypass left-turn storage lane, lengthen and widen S.R. 5 right-turn storage lane, add black blanks to signal heads, add strobe light to signal.

Other Accident Types - Right Angle and Turning Movement

Possible Causes - Excessive speed, unclear lane markings, short amber phase on signal.

Possible Countermeasures - Enforcement of speed limits, proper lane markings, longer amber phase.

The statistical correlation work done by Van Maren (3) shows a significant reduction in the accident rate at signalized intersections due to overhead bars on the major road and route markers as advance warning on the minor road. Both of these exist at this intersection. A stop or signal ahead sign on the minor road was shown to have only a minor effect on reduction of the accident rate, and the presence of a stop or signal ahead and route marker or a route marker only as advance warning on the major road was correlated with a higher accident rate.

The computer simulation model was used to evaluate the existing condition with the following possible changes: 1) advance warning system through the provision of rumble strips on the major road (U.S. 24), 2) an increase of maximum extension, and 3) an increase in amber phase duration. The results of the simulation model runs showed no reduction in the number of conflicts through any of the measures considered. However, the provision of rumble strips significantly reduced the stop delay per vehicle (see Table 3-4).

Conclusion

The total number of accidents at this intersection during the study period has not been high, but the severity of the accidents shows that excessive speed for conditions is the primary concern at this location.

The traffic volumes and accident history at this intersection do not justify expensive countermeasures such as reconstruction of the turn lanes. However, relatively inexpensive countermeasures designed to reduce accident severity should be implemented. Our recommendations are to install advance warning signs on all approaches to this intersection, install a strobe light in the red signal heads on U.S. 24 Bypass, and to conduct a signal-timing study to determine if an increase in the amber phase and/or an all-red phase is justified at this location.

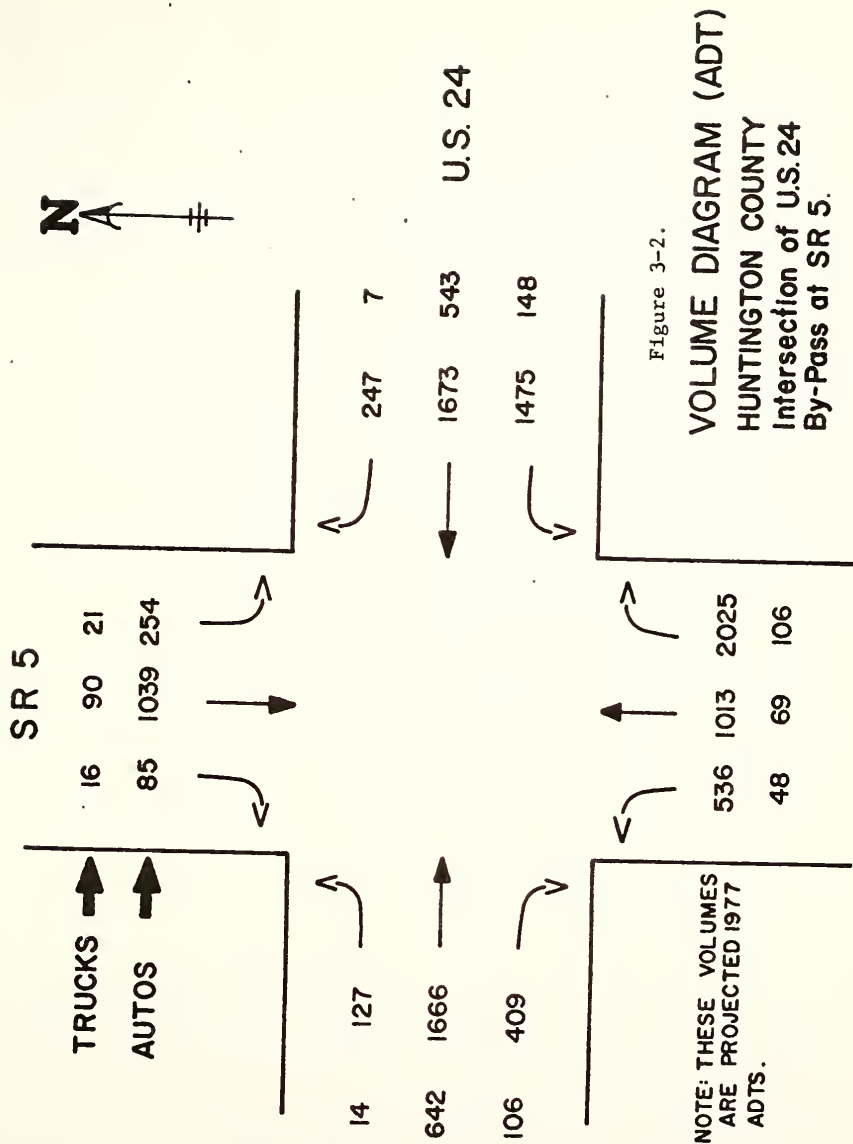


Table 3-1.

ACCIDENT

SUMMARY

LOCATION:	US 24 Bypass at SR 5(Jefferson St.)
	Huntington County
PERIOD:	1-1-74 to 12-31-74
DISTRICT:	Fort Wayne

TOTAL ACCIDENTS	DAY	DARK
7	6	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
2	4	1	5	1

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
2	4	1	L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
5	2		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
	1		1	1	1	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM											1		1
PM		1		1		2	2						6

Table 3-2.

ACCIDENT

SUMMARY

LOCATION:	Us 24 Bypass at SR 5 (Jefferson St.)
	Huntington County
PERIOD:	1-1-75 to 12-31-75
DISTRICT:	Fort Wayne

TOTAL ACCIDENTS	DAY	DARK
6	5	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
4	2		10	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3	1		L= 2 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
6			

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
			1		4	1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1					1
PM		1			1	1	1	1					5

Table 3-3.

ACCIDENT

SUMMARY

LOCATION: US 24 Bypass at SR 5 (Jefferson St.)

Huntington County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Fort Wayne

TOTAL
ACCIDENTS

5

DAY

DARK

5

PERSONAL
INJURY

1

PROPERTY
DAMAGE

4

FATAL

INJURED

1

KILLED

REAR END

RIGHT ANGLE

OUT OF
CONTROLTURNING
MOVEMENT

4

L= 1 R=

SIDE SWIPE

HEAD ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

WET

SNOW/ICE

OTHER

4

1

SUN.

MON.

TUES.

WED.

THUR.

FRI.

SAT.

1

1

1

2

TIME FACTOR * 1 NOT GIVEN

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM											1		1
PM		1			1	1							3

Table 3-4. Stop Delay Per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Three Suggested Countermeasures at U.S. 24 at S.R. 5 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	65.99	20	0
Rumble Strips on Major	49.97	57	0
Increase Maximum Extension	67.96	38	1
Increase Amber	64.59	31	3

SITE NO. 4

U.S. 31 and S.R. 18 Intersection

Description of U.S. 31 and S.R. 18 Intersection

The intersection of U.S. 31 and S.R. 18 is located in Miami County in the Fort Wayne district of the Indiana State Highway Commission. U.S. 31 is a four-lane divided highway with left and right turn lanes at the intersection. S.R. 18 is a two-lane highway. The intersection is controlled by flashers stopping the S.R. 18 traffic, and by a median stop sign for S.R. 18.

The traffic volume on U.S. 31 is approximately 8000 vehicles per day in each direction, and that on S.R. 18 is approximately 2000 vehicles per day in each direction. Turning movements are relatively heavy, especially right turns from northbound U.S. 31 to eastbound S.R. 18, and left turns from westbound S.R. 18 to southbound U.S. 31.

The accident history for this intersection shows 27 accidents including 18 personal injuries for the three study years.

Evaluation of the Intersection

The intersection was evaluated by analyzing the written comments of the team members who studied the intersection in the field, and developing a consensus from the comments.

Predominant Accident Type - Right Angle

Primary Cause - S.R. 18 traffic failing to yield right-of-way to U.S. 31 traffic. The team members felt that many of the drivers on S.R. 18 were attempting to cross U.S. 31 or make left turns onto U.S. 31 in one movement without stopping in the median. Because of the speeds and volume of traffic on U.S. 31 this is a dangerous maneuver.

Consensus Countermeasure - Widen the median to provide adequate room for vehicles waiting to cross or turn onto U.S. 31.

Other Possible Causes - Lack of visibility of flashers due to possible sun glare, speed of vehicles on U.S. 31, turning traffic interfering with crossing traffic.

Other Possible Countermeasures - Add black shields to the flasher heads, enforcement of speed limits, reconstruction of the intersection.

Other Accident Types

The other accident types were insignificant at this intersection.

Van Maren's research (3) shows a strong correlation between an increase in median width and a decrease in accident rates for signalized intersections, but a very weak correlation between median width and accident rates for non-signalized intersections such as this.

The simulation model experiments indicated that as median width increased, the number of conflicts decreased. In addition, model runs were made for this intersection with the following countermeasures: 1) advance warning through the provision of rumble strips on S.R. 18, and 2) advance warning sign provided with strobe light. The results indicated no reduction in rearend and right angle conflicts from those experienced under existing condition; however, the provision of advanced warning systems significantly reduced the number of left turn conflicts (see Table 4-1).

Conclusion

With the extremely high percentage of right-angle collisions at this intersection it is apparent that vehicles on S.R. 18 are not accepting safe gaps in the U.S. 31 traffic. Three possible problems may be easily identified: S.R. 18 vehicles not stopping for the median stop sign, attempting to complete their crossover or turn in one continuous movement; vehicles stopping for the stop sign but overhanging the through lanes because of insufficient median width, either because of vehicle length such

as a boat trailer or because they are the second or third vehicle in a queue; and conflicts between S.R. 18 traffic at the median stop and U.S. 31 vehicles attempting to turn left.

The first two of these problems could be reduced by increasing the median width, and the third could be solved by signalizing the intersection.

The reconstruction of the entire intersection to increase the median width cannot be justified economically by the accident history at this intersection. Signalization of the intersection would undoubtedly change the accident pattern, but not necessarily improve the situation, and would certainly increase total vehicular delay. Our recommendation is to increase the size of the median stop sign for S.R. 18, and to rigorously enforce this stopping maneuver.

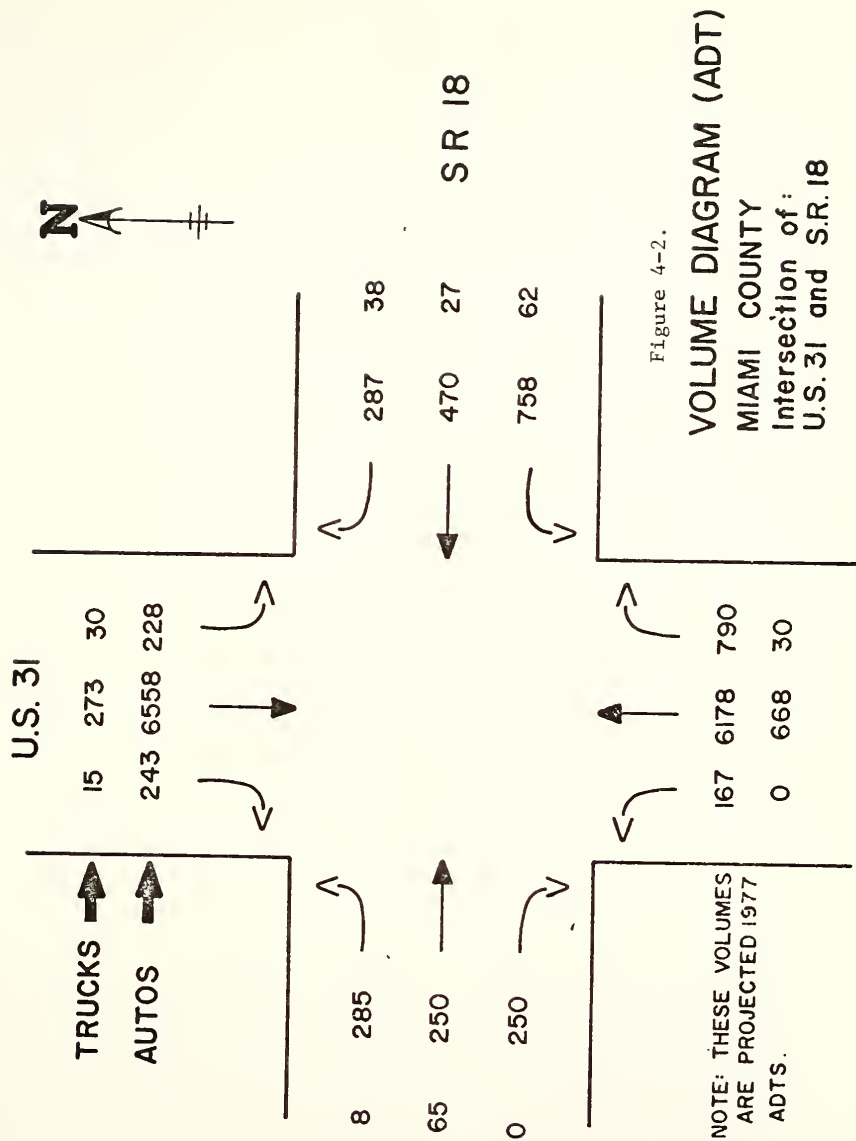


Figure 4-4.

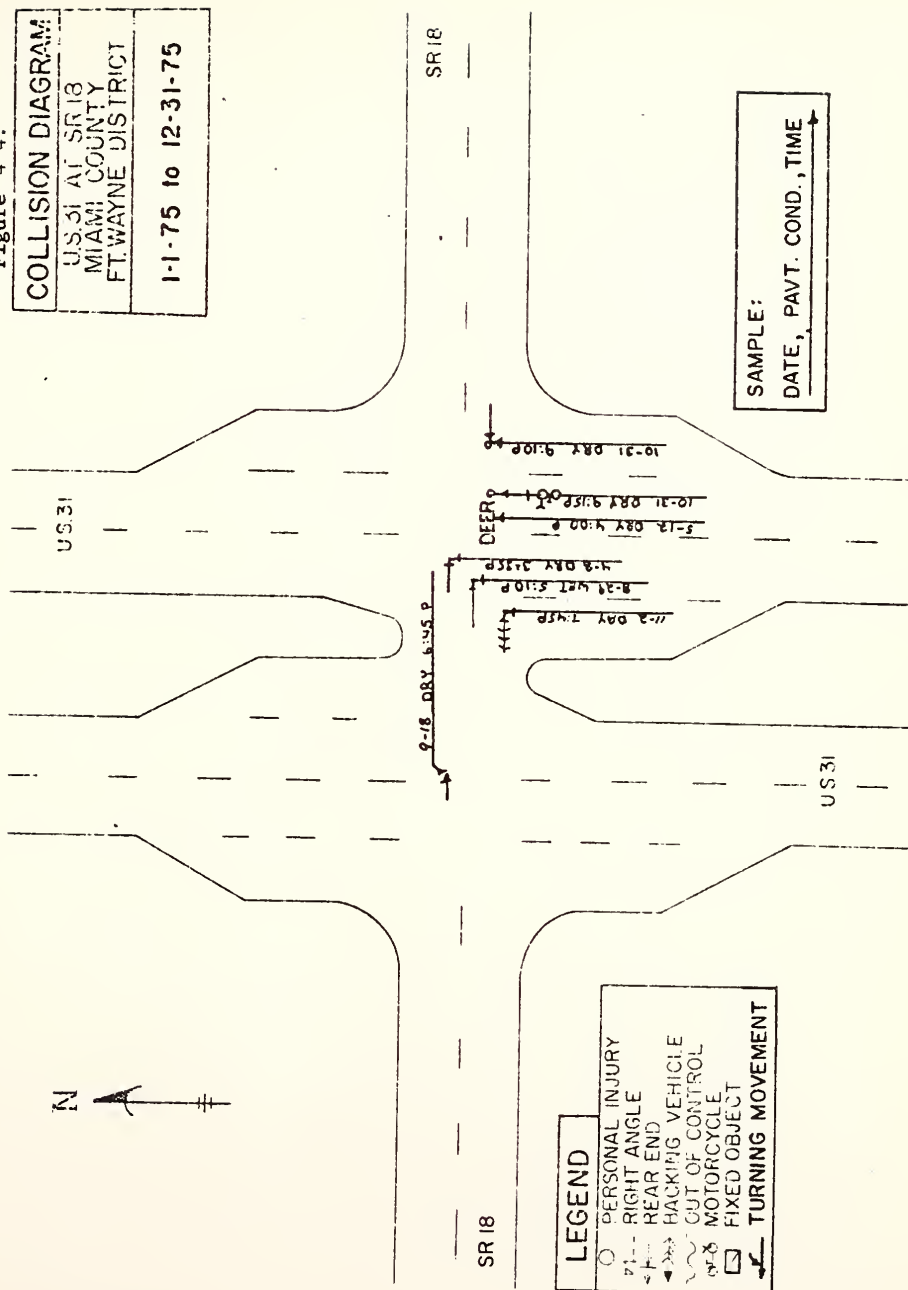


Table 4-1.

ACCIDENT

SUMMARY

LOCATION:	US 31 at SR 18
	Miami County
PERIOD:	1-1-74 to 12-31-74
DISTRICT:	Fort Wayne

TOTAL ACCIDENTS	DAY	DARK
9	9	

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
4	5		5	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
2	6		L= R= 1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
8	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	2	2	1	1	1	

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1		1	1	3
PM				1	2	2	1						6

Table 4-2.

ACCIDENT

SUMMARY

LOCATION:	US 31 at SR 18
	Miami County
PERIOD:	1-1-75 to 12-31-75
DISTRICT:	Fort Wayne

TOTAL ACCIDENTS	DAY	DARK
7	3	4

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
2	5		2	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
1	3		L= 1 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
6	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1	1	1		1	3	

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM													
PM				1	1	1	1	1		2			7

Table 4-3.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR18

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Fort Wayne

TOTAL
ACCIDENTS

11

DAY

9

DARK

2

PERSONAL
INJURY

6

PROPERTY
DAMAGE

5

FATAL

INJURED

11

KILLED

REAR END

RIGHT ANGLE

8

OUT OF
CONTROL

2

TURNING
MOVEMENT

L= 1 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

11

WET

SNOW/ICE

OTHER

SUN.

2

MON.

TUES.

WED.

1

THUR.

2

FRI.

3

SAT.

3

TIME FACTOR

12-1

1-2

2-3

3-4

4-5

5-6

6-7

7-9

8-9

9-10

10-11

11-12

TOTAL

AM

1

1

PM

1

2

6

1

10

Table 4-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at U.S. 31 - S.R. 18 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	6.00	10	27
Providing Rumble Strips	4.66	13	21
Providing Advance Warning Signs with Strobe	4.81	12	18

SITE NO. 5

S.R. 37 and S.R. 48 Intersection

Description of S.R. 37 and S.R. 48 Intersection

The intersection of S.R. 37 and S.R. 48 is located in Monroe County in the Seymour district of the Indiana State Highway Commission. S.R. 37 is a four-lane divided highway with left and right turn lanes at the intersection. S.R. 48 is a two-lane highway approaching the intersection from each direction, widening to a four-lane highway with additional left turn lanes at the intersection, with a guard rail separating the left turn lanes from the opposing traffic on both approaches. The intersection is controlled by an actuated traffic signal.

The traffic volume on S.R. 37 is approximately 6000 to 7000 vehicles per day in each direction, with approximately the same volumes in each direction on S.R. 48. Turning movements at the intersection are quite high.

The intersection has had a serious accident experience with 83 accidents occurring over the three year study period, with 5 fatalities and 62 personal injuries.

Evaluation of the Intersection

The evaluation of the intersection was made by analyzing the written comments of the investigative team members, and developing a consensus from the comments.

Predominant Accident Type - Left Turning Movement

Primary Cause - Opposing turn lanes on S.R. 37 blocking visibility of oncoming through traffic.

Consensus Countermeasure - Separate left turn phase for S.R. 37 traffic.

Other Possible Causes - Speed of vehicles on S.R. 37.

Other Possible Countermeasures - Enforcement of S.R. 37 speed limit.

Other Accident Types - Right Angle and Rearend

Possible Causes - Speed on S.R. 37, unexpected stops, visibility of signals.

Possible Countermeasures - Enforcement of speed limits, longer amber and/or all-red phase on signal, larger signal lenses.

Van Maren's research (3) did not include any work on signalized intersections with separate left-turn signal phases.

Radwan (2) showed that a separate left-turn phase significantly reduced left-turning movement conflicts, but increased total delay to the extent that a separate left-turn phase is not economically justified at this intersection. Specific model runs were also made with 1) an increase in left turn phase duration to 24 seconds and, 2) installation of strobe lights on the major road on advance warning signs. However, no reduction in the number of right angle and rearend conflicts was observed, but the number of left turn conflicts was reduced under both of these measures, the reduction being more significant when advance warning system with strobe lights was used (see Table 5-4).

Conclusion

There were more left-turning movement accidents at this location than any other type, but the right angle and rearend accidents were also very numerous, and the severity of all of the types, as evidenced by the number of injuries and fatalities, is of serious concern. The consensus countermeasure of providing a separate left-turn phase for S.R. 37 traffic obviously addresses only one of these problems. The intersection is clearly not functioning properly.

The traffic volumes are not particularly heavy, but the turning movements in all directions are a significant percentage of these volumes.

Rearend accidents of S.R. 48 were numerous in the first two years of the study period, but were significantly reduced the final year, possibly indicating that local drivers were becoming familiar with the operation of the intersection.

The fact that all three major accident types - turning movement, rearend, and right angle - exist in large numbers, combined with the severity of the accidents, indicates two things: first, that vehicles in one direction are not clearing the intersection before high-speed vehicles in the other direction enter the intersection; and second, that some vehicles are travelling at too high a rate of speed to stop for vehicles ahead which stop unexpectedly for a signal change. Our recommendations are to provide an all-red clearance phase in the signal, to reduce the right-angle accidents; to put a strobe light in the red signals on all four legs of the intersection; and to conduct a signal timing study to see if a separate left-turn phase is warranted.

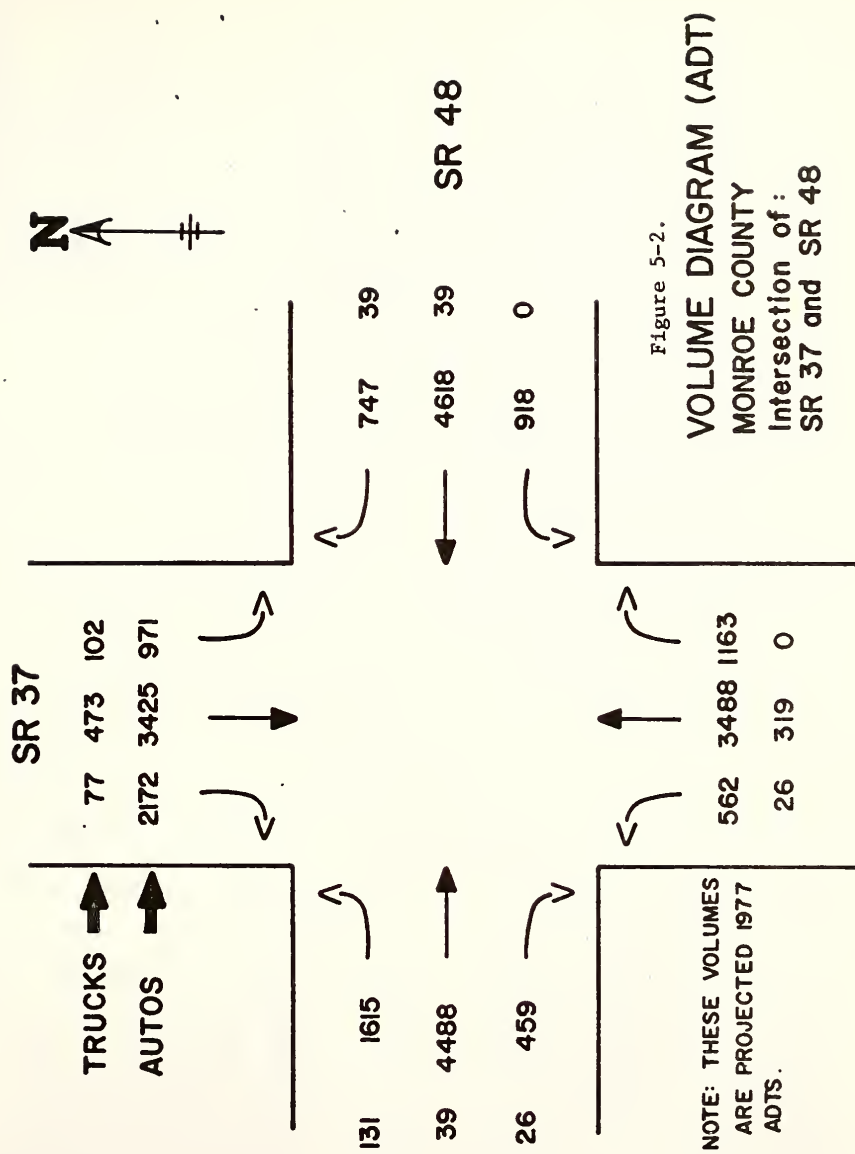


Figure 5-3.

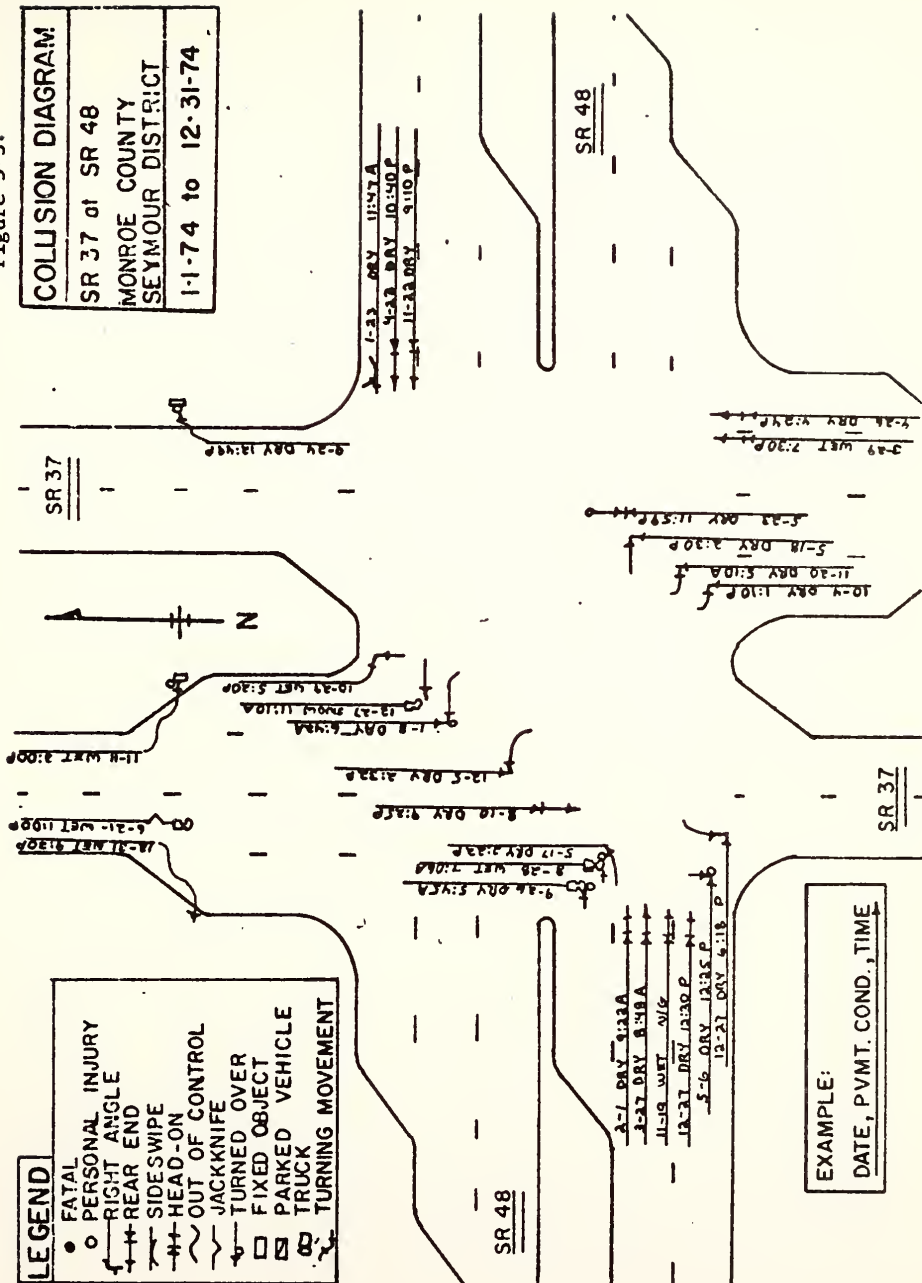




Table 5-1.

ACCIDENT

SUMMARY

LOCATION: SR 37 Bypass at SR 48 (Whiehall Pk. & 3rd. St.)

Monroe County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Seymour

TOTAL
ACCIDENTS

27

DAY

19

DARK

8

PERSONAL
INJURY

7

PROPERTY
DAMAGE

19

FATAL

1

INJURED

9

KILLED

1

REAR END

9

RIGHT ANGLE

4

OUT OF
CONTROL

3

TURNING
MOVEMENT

L= 8 R=

SIDE SWIPE

1

HEAD-ON

1

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

19

WET

7

SNOW/ICE

1

OTHER

SUN.

MON.

2

TUES.

8

WED.

4

THUR.

2

FRI.

9

SAT.

2

TIME FACTOR *1 NOT GIVEN

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM						2	1	1	1	1		2	8
PM	4	1	3	1	1	1	1	1		3	1	1	18

Table 5-2.

ACCIDENT

SUMMARY

LOCATION:	SR 37 Bypass at SR 48 (Whitefall Pk. & 3rd. St.) Monroe County
PERIOD:	1-1-75 to 12-31-75
DISTRICT:	Seymour

TOTAL ACCIDENTS	DAY	DARK
32	24	8

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
11	19	2	32	3

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
9	8	3	L= 9 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
23	8	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	8	2	8	5	2	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1	4	1	2	4	12
PM	2	1	2	1	2	3		2	4	1		2	20

Table 5-3.

ACCIDENT

SUMMARY

LOCATION: SR 37 Bypass at SR 48 (Whitehall Pike & 3rd St.)
Monroe County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Seymour

TOTAL ACCIDENTS	DAY	DARK
24	17	7

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	14	1	21	1

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	6	1	L= 9 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			3

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
20	2	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
	3	3	3	6	6	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1	2				1	1		1	2		2	10
PM	2			2	3	1		2	1	1	1	1	14

Table 5-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at S.R. 37 at S.R. 48 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	12.63	8	94
Increase Left Turn Phase Duration	18.91	10	82
Install Strobe on Major	13.29	10	63

SITE NO. 6

South Junction of S.R. 39 and S.R. 67

Description of the South Junction of S.R. 39 and S.R. 67

The south junction of S.R. 39 and S.R. 67 is located in Morgan County in the Seymour district of the Indiana State Highway Commission. S.R. 67 is a four-lane divided highway with left turn lanes at the intersection, and a channelized right turn lane to S.R. 39. S.R. 39 is a two-lane facility east of the intersection with a channelized right turn lane north-bound. The fourth, or west, leg of the intersection is a two-lane county road. The intersection is controlled by an actuated signal.

The traffic volumes on S.R. 67 are approximately 4000 to 6000 vehicles per day in each direction. S.R. 39 has a volume of approximately 8000 vehicles per day in each direction, with the county road carrying approximately 1000 vehicles per day each way.

There has been a total of 27 accidents over the three year study period, with ten personal injuries.

Evaluation of the Intersection

The evaluation of this intersection was made by an analysis of the written comments of the team members, with a consensus drawn from these comments.

Predominant Accident Type - Rearend

Primary Cause - Speed of vehicles on southbound S.R. 67. The team members felt that the drivers on S.R. 67, especially those southbound, were not prepared for the intersection.

Consensus Countermeasure - Additional advance warning of signal.

Other Possible Causes - None.

Other Possible Countermeasures - Enforcement of speed limit, speed bumps, increased time in amber phase of signal, increased size of traffic signal lenses, increased visibility of traffic signals by changing location of overhead signs.

Other Accident Types

The other accident types were insignificant at this intersection.

Van Maren's research (3) did not consider the size or number of advance warning signs at intersections.

The simulation model was run for this intersection with the existing condition and with an installation of advance warning system through strobe lights. With the provision of strobe lights stop delay per vehicle as well as number of conflicts in all categories were significantly reduced with respect to the present condition (see Table 6-4).

Conclusion

The accident history at this location has not been too bad, comparatively, either in terms of total number or severity of accidents. Expensive counter-measures cannot be justified, but speed reduction and increased awareness of the intersection on the part of S.R. 67 drivers, particularly southbound, would be beneficial. Our recommendation is to add a strobe light to the advance warning signs on S.R. 67.

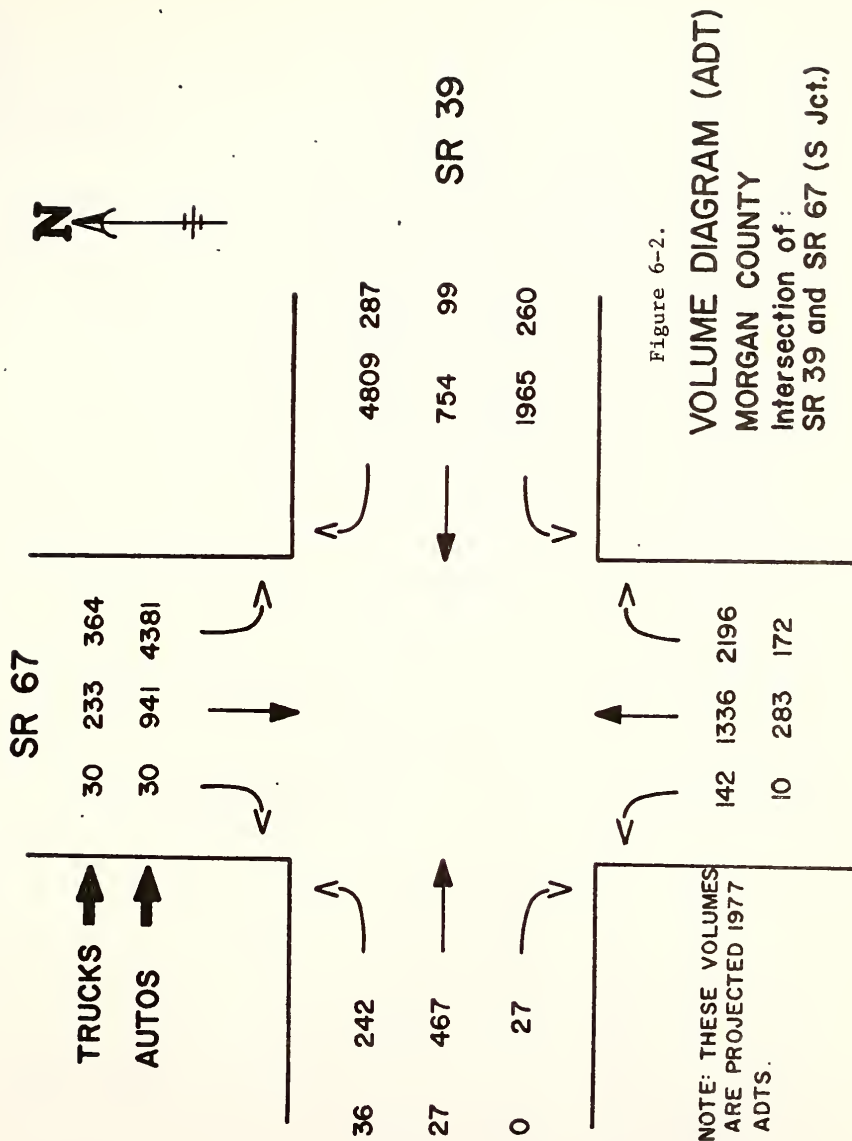


Figure 6-5.

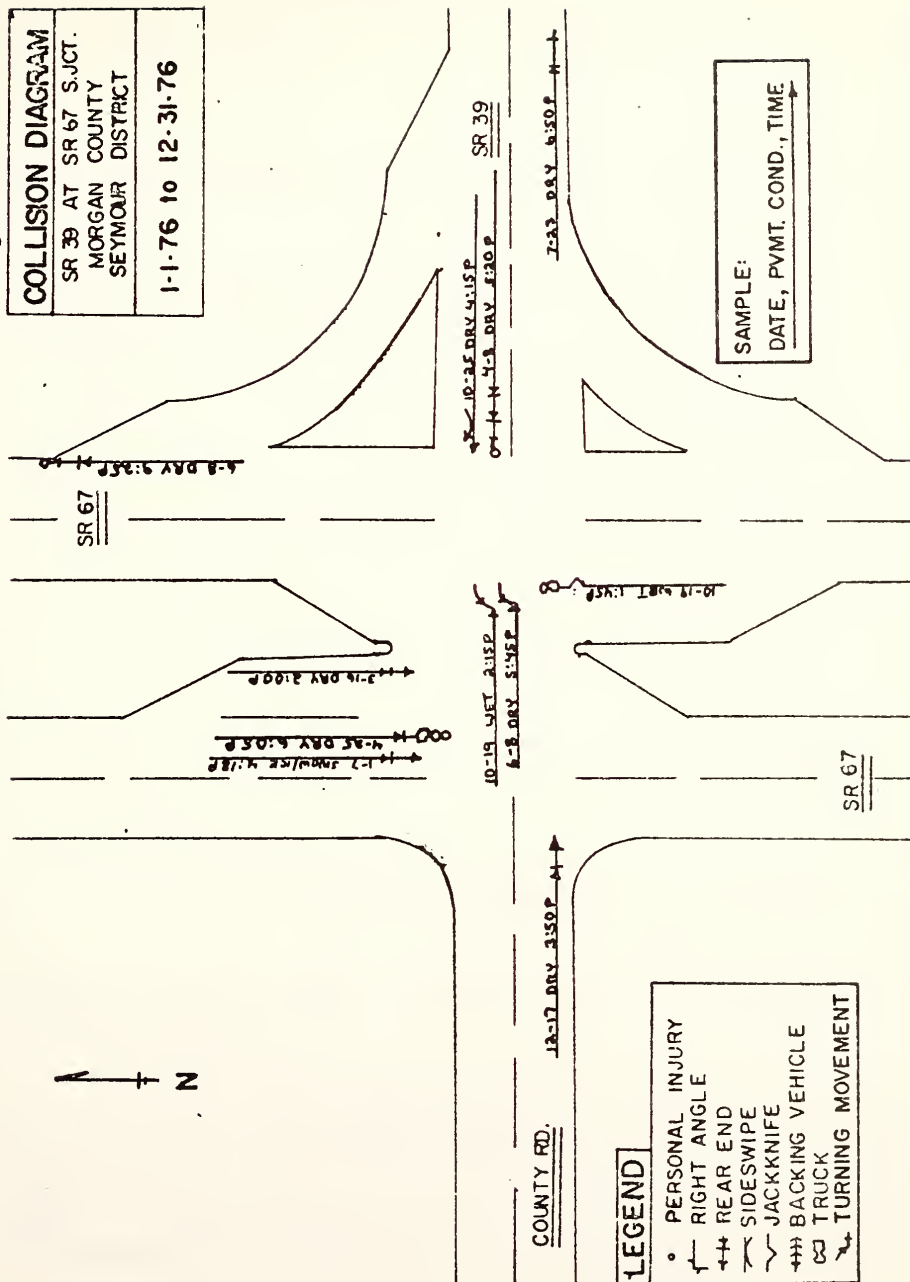


Table 6-1.

ACCIDENT

SUMMARY

LOCATION: SR 39 at SR 67 (S. Jct.)

Morgan County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Seymour

TOTAL
ACCIDENTS

6

DAY

DARK

3

3

PERSONAL
INJURYPROPERTY
DAMAGE

FATAL

INJURED

KILLED

3

3

5

REAR END

RIGHT ANGLE

OUT OF
CONTROLTURNING
MOVEMENT

5

1

L= R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

WET

SNOW/ICE

OTHER

4

2

SUN.

MON.

TUES.

WED.

THUR.

FRI.

SAT.

2

1

2

1

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1				1
PM	1		1		1				1		1		5

Table 6-2.

ACCIDENT

SUMMARY

LOCATION: SR 39 at SR 67 (S. Jct.)
Morgan County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Seymour

TOTAL ACCIDENTS	DAY	DARK
10	9	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
3	7		4	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
4	4		L = 1 R =

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
6	4		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2			1	3	3	1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1	2			3
PM		1		2	3					1			7

Table 6-3.

ACCIDENT

SUMMARY

LOCATION: SR 39 at SR 67 (S. Jct.)
Morgan County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Seymour

TOTAL ACCIDENTS	DAY	DARK
6	3	3

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
3	3		5	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	1		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
4	2		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1	2		1		

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1				1
PM	1		1		1				1		1		5

Table 6-4. Stop Delay per Vehicle, Number of Conflicts and Left-Turn Conflicts for Existing Condition and One Suggested Countermeasure at S.R. 67 at S.R. 39 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	195.47	2	65
Install Strobe	136.12	0	56

SITE NO. 7

S.R. 37 and S.R. 252 Intersection

Description of S.R. 37 and S.R. 252 Intersection

The intersection of S.R. 37 and S.R. 252 is in Morgan County in the Seymour district of the Indiana State Highway Commission. S.R. 37 is a six-lane divided highway with left and right turn lanes on the north leg, and a left turn lane on the south leg. S.R. 252 is a two-lane highway. The intersection is controlled by an actuated traffic signal.

The traffic volume on S.R. 37 is approximately 6000 to 8000 vehicles per day in each direction, and on S.R. 252 is approximately 2400 vehicles per day in each direction. The turning movements at the intersection are not excessive.

The accident history for this intersection shows 64 accidents for the three year study period, including one fatality and 51 personal injuries.

Evaluation of the Intersection

The evaluation of this intersection was obtained by an analysis of the written comments of the various team members, with a consensus drawn from these comments.

Predominant Accident Type - Right Angle

Primary Cause - Inability or unwillingness of drivers to stop for traffic signal on relatively steep downgrade southbound on S.R. 37.

Consensus Countermeasure - Reduce grade on S.R. 37.

Other Possible Causes - None.

Other Possible Countermeasures - Enforcement of speed limit, rumble strips on S.R. 37, longer amber signal phase, all-red clearance phase in signal, larger lenses in signal, adding flashers to advance warning signs.

Other Accident Types - Left-Turning Movement and Rearend

Possible Causes - Shadow effect on left-turns, excessive speed of vehicles on S.R. 37.

Possible Countermeasures - Separate left-turn phase in the signal, enforcement of the speed limit, longer amber signal phase, larger traffic signal lenses, adding strobe light to all phases of the signal.

Van Maren's research (3) showed no significant correlation between highway grades and accident rates, and Radwan's simulation experiments (2) showed a significant increase in conflicts caused by major highways on downgrades.

The simulation model was run for this intersection with the existing condition and assuming the installation of a separate left turn phase. Although the provision of a separate left turn phase reduced the stop delay per vehicle, the number of left turn conflicts was reduced only to a small extent and there was no change in other conflicts (see Table 7-4).

Conclusion

This intersection has had a poor accident history, both in terms of numbers of accidents and in the severity of the accidents. Most of the accidents of all three types, right-angle, left-turning movement and rear-end, have involved southbound S.R. 37 vehicles. Because of the tremendous expense involved in completely rebuilding S.R. 37 to reduce the grade, this countermeasure cannot be justified at this time. Our recommendation for this intersection is to provide flashers on advance warning signs on S.R. 37, located well in advance of the intersection, particularly southbound, and to provide an all-red clearance phase in the signal.

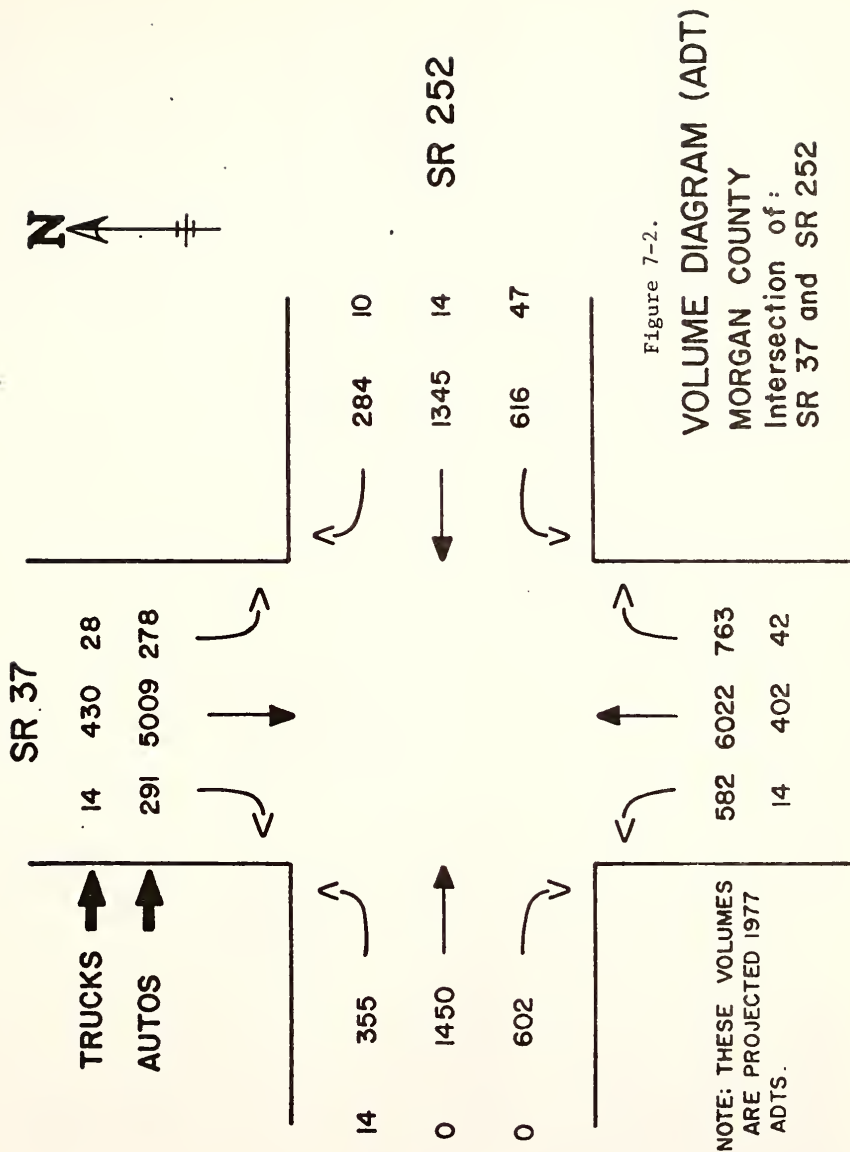


Figure 7-4.

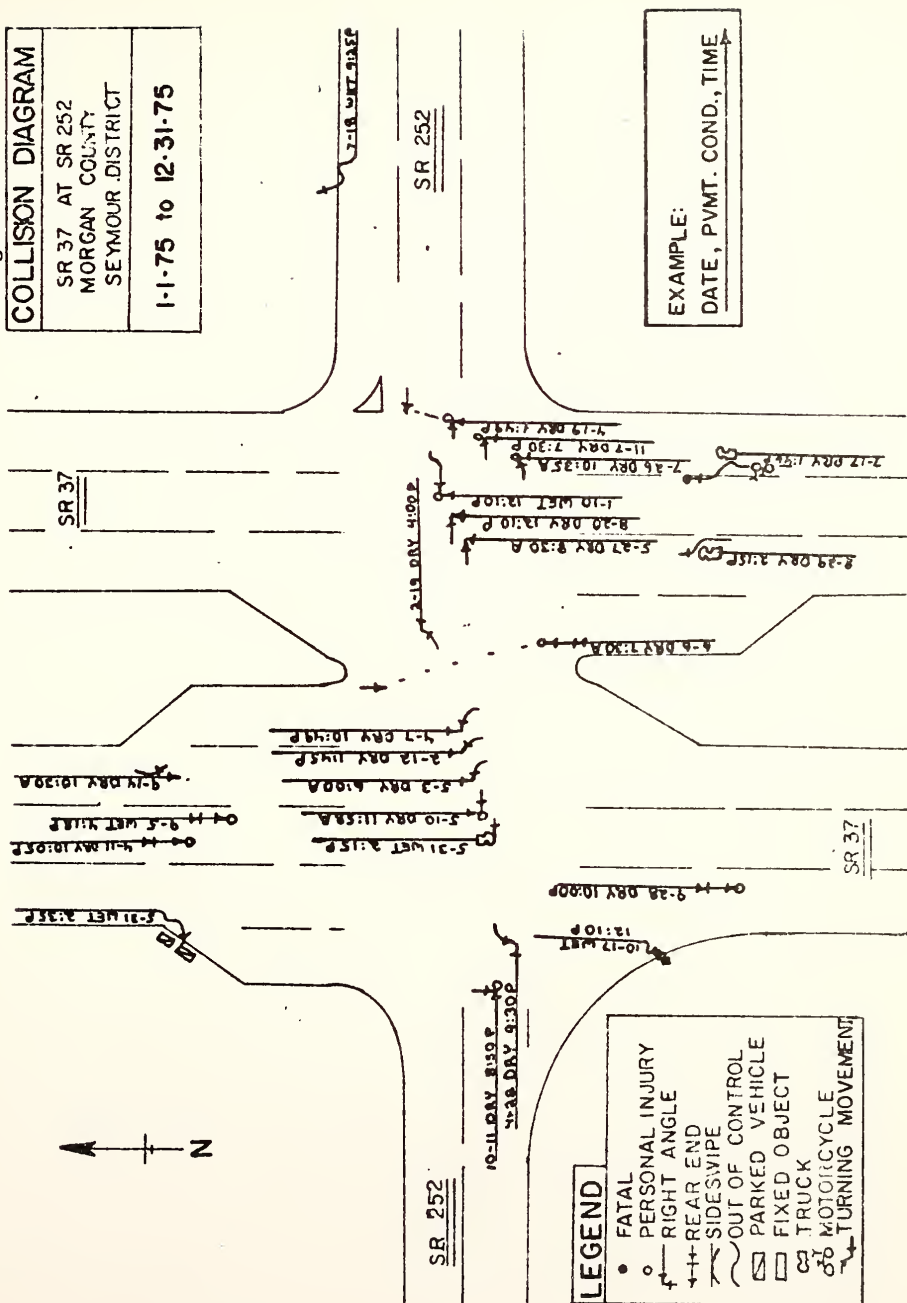


Table 7-1.

ACCIDENT

SUMMARY

LOCATION: SR 37 at SR 252												
Morgan County												
PERIOD: 1-1-74 to 12-31-74												
DISTRICT: Seymour												

TOTAL ACCIDENTS	DAY	DARK
18	14	4

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
10	8		20	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3	9		L= 5 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
17	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1	1	3	2	2	5	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								2	1		1	1	5
PM	1	4	2		1		1	2	1	1			13

Table 7-2.

ACCIDENT

SUMMARY

LOCATION:	SR 37 at SR 252
	Morgan County

PERIOD:	1-1-75 to 12-31-75
---------	--------------------

DISTRICT:	Seymour
-----------	---------

TOTAL ACCIDENTS	DAY	DARK
24	17	7

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
10	13	1	19	1

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
4	5	3	L= 6 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			5

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
18	6		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	2	2	3	1	7	7

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM							1	1	1		2	1	6
PM	3	3	3		2			1	1	2	3		18

Table 7-3.

ACCIDENT

SUMMARY

LOCATION:	SR 37 at SR 252
	Morgan County

PERIOD:	1-1-76 to 12-31-76
---------	--------------------

DISTRICT:	Seymour
-----------	---------

TOTAL ACCIDENTS	DAY	DARK
22	15	7

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	13		12	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	7		L= 6 R= 1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			3

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
20	2		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1	5	3	3	4	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM							1	2			1	2	6
PM	1	1	2		3	2	4		1	1		1	16

Table 7-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and One Suggested Countermeasure at S.R. 37 at S.R. 252 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	7.69	7	30
Install Left Turn Phase	5.89	7	26

SITE NO. 8

U.S. 31 and S.R. 14 Intersection

Description of U.S. 31 and S.R. 14 Intersection

The intersection of U.S. 31 and S.R. 14 is located in Fulton County in the LaPorte district of the Indiana State Highway Commission. U.S. 31 is a four-lane divided highway with left and right turn lanes at the intersection. S.R. 14 is a two-lane highway with a right turn lane on the west leg of the intersection. The intersection is at a skew of 72° and U.S. 31 is on a 2° curve through the intersection with the pavement super-elevated. The intersection is controlled by flashers, with stop signs for S.R. 14 traffic at the northbound and southbound pavement edges and in the median.

The traffic volumes are relatively light at this intersection, with U.S. 31 carrying approximately 2000 to 2200 vehicles per day in each direction, and S.R. 14 carrying approximately 900 vehicles per day in each direction.

During the three year study period there were 27 accidents, including one fatality and 24 personal injuries at this intersection.

Evaluation of the Intersection

The intersection was evaluated by analysis of the written comments of the investigative team members, with a consensus drawn from the comments.

Predominant Accident Type - Right Angle

Primary Cause - Lack of visibility of southbound U.S. 31 traffic.

Consensus Countermeasure - Reduce grade, curve, and/or superelevation on north leg of U.S. 31.

Other Possible Causes - Excessive speed of traffic on U.S. 31.

Other Possible Countermeasures - Enforcement of speed limits, flashers on advance warning signs of U.S. 31.

Other Accident Types

The other accident types were insignificant at this intersection.

Van Maren's research (3) showed a strong correlation between an increase in horizontal curvature and an increase in the accident rate. Radwan's simulation experiments (2) did not include analysis of horizontal curvature. However, the simulation model was run assuming two changes and compared with the model results from the existing condition. The first change involved a reduction in speed on S.R. 14 from 45 mph to 35 mph and the second run simulated a reduction of speed on U.S. 31 from 55 mph to 45 mph. The comparison of results showed a drastic drop in rearend and right angle conflicts, but no reduction in left turn conflicts (see Table 8-4).

Conclusion

The severity of the accidents, not the total number of accidents, has been a problem at this intersection, indicating that speed has been a factor. The total rebuilding of the intersection to reduce the horizontal curvature in accordance with the concensus countermeasure would be excessively expensive, and cannot be justified by the accident history at this location.

Virtually all of the accidents involved southbound U.S. 31 traffic, indicating that S.R. 14 traffic crossing the southbound lanes or turning south onto U.S. 31 are not accepting safe gaps in the U.S. 31 traffic. Our recommendation is to slow down U.S. 31 traffic by adding flashers with a strobe light to the advance warning sign on U.S. 31 southbound.

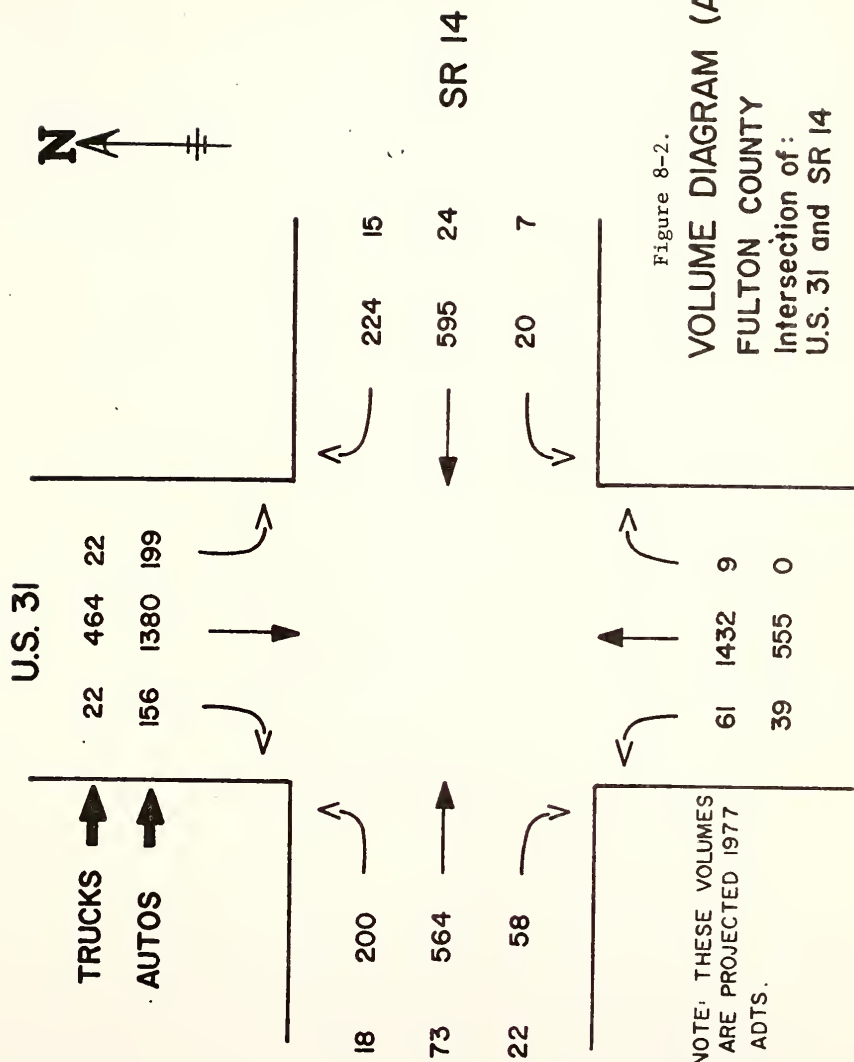


Figure 8-4.

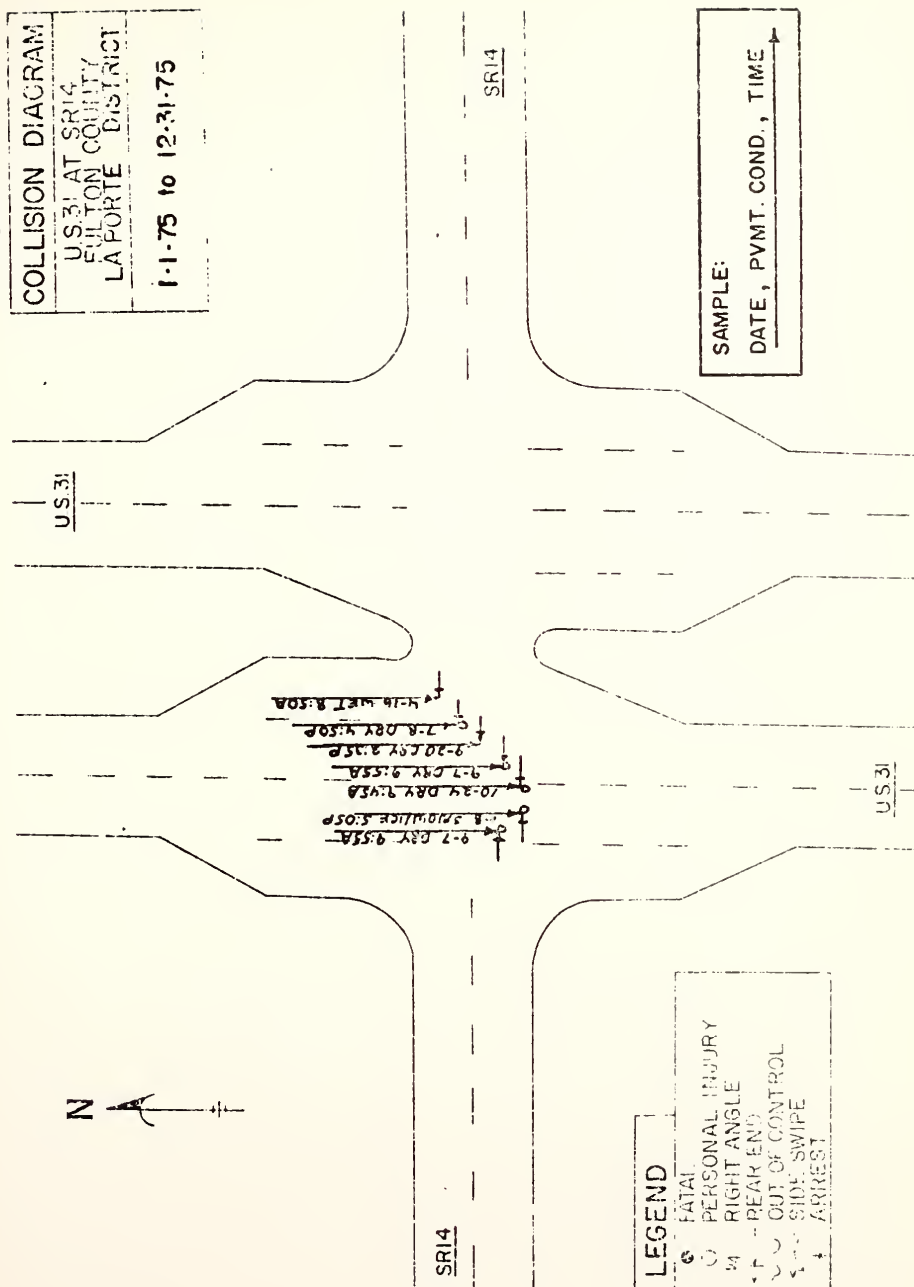


Table 8-1.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 14
Fulton County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: LaPorte

TOTAL ACCIDENTS	DAY	DARK
12	11	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	3		10	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
1	8		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
9	3		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3		2	2	1	1	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									2	1	1	2	6
PM				1	3			1		1			6

Table 8-2.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 14

Fulton County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: LaPorte

TOTAL
ACCIDENTS

7

DAY

DARK

7

PERSONAL
INJURY

5

PROPERTY
DAMAGE

2

FATAL

INJURED

9

KILLED

REAR END

RIGHT ANGLE

7

OUT OF
CONTROLTURNING
MOVEMENT

L= R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

5

WET

1

SNOW/ICE

1

OTHER

SUN.

1

MON.

TUES.

WED.

3

THUR.

FRI.

1

SAT.

2

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1	2			3
PM			1		1	1	1						4

Table 8-3.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 14

Fulton County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: LaPerte

TOTAL
ACCIDENTS

8

DAY

DARK

7

1

PERSONAL
INJURY

2

PROPERTY
DAMAGE

5

FATAL

1

INJURED

5

KILLED

1

REAR END

1

RIGHT ANGLE

6

OUT OF
CONTROLTURNING
MOVEMENT

L= R= 1

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

7

WET

SNOW/ICE

1

OTHER

SUN.

3

MON.

1

TUES.

1

WED.

THUR.

FRI.

1

SAT.

2

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM											2		2
PM		1	1	2		1			1				6

Table 8-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at U.S. 31 at S.R. 14 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	0.70	6	17
Reduce Speed on Minor	0.95	2	21
Reduce Speed on Major	1.41	1	16

SITE NO. 9

U.S. 41 and 45th Avenue Intersection

Description of U.S. 41 and 45th Avenue Intersection

The intersection of U.S. 41 and 45th Avenue is in Lake County in the LaPorte District of the Indiana State Highway Commission. It is located in the outskirts of the city of Highland, Indiana. U.S. 41 is an undivided four-lane highway with left-turn bays at the intersection. 45th Avenue is an undivided suburban street. The intersection is controlled by a traffic signal actuated by 45th Avenue traffic.

The traffic volumes are approximately 13000-15000 vehicles per day in each direction on U.S. 41, and 3000-5000 vehicles per day in each direction on 45th Avenue. Turning movements at the intersection are heavy.

There has been a total of 116 accidents at the intersection during the three year study period, with 41 injuries.

Evaluation of the Intersection

The independent team discussed this intersection at a team meeting, and developed the following team consensus as to predominant accident types, causes and countermeasures.

Predominant Accident Type - Rearend

Primary Cause - Poor signal visibility.

Consensus Countermeasure - Install traffic signals in a box configuration rather than the existing diagonal installation.

Other Causes - Insufficient advance warning, slick pavements.

Other Countermeasures - Install an overhead advance warning sign for U.S. 41 traffic in each direction, check skid resistance and resurface if necessary.

Other Accident Type - Left Turning Movement

Possible Causes - Improper signal timing, driver confusion as to lane usage.

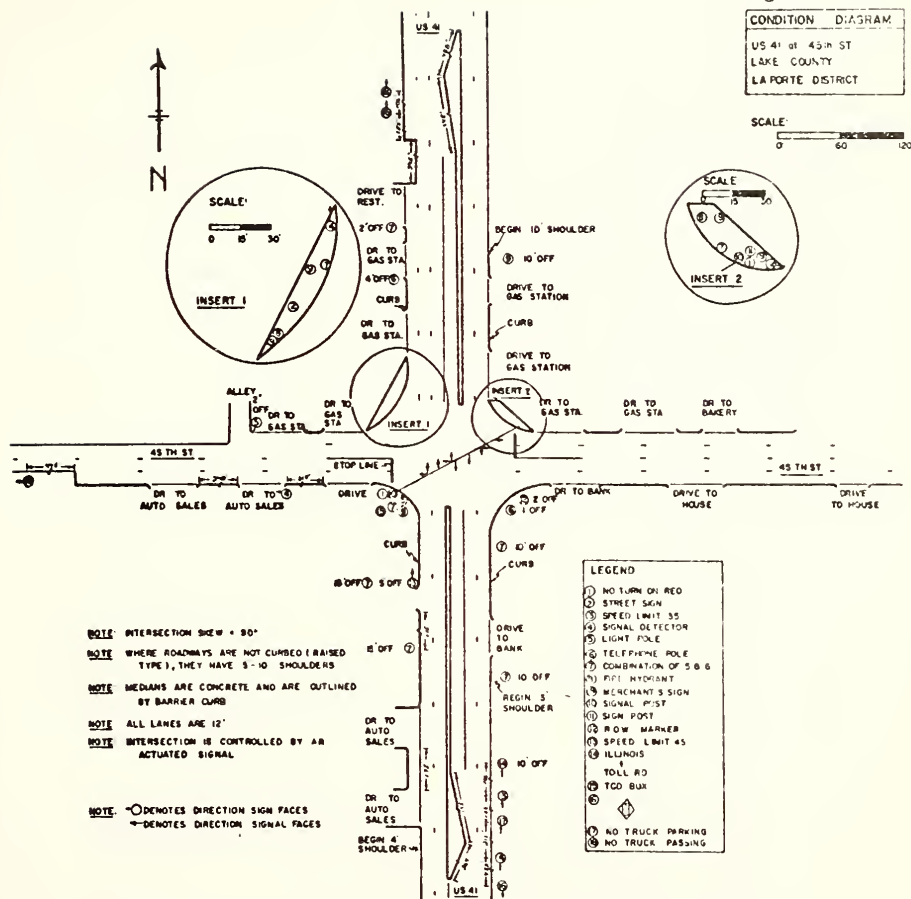
Possible Countermeasures - Shorten the amber and/or all-red phases, install a "Wait-Delayed Signal" sign facing U.S. 41 through traffic, paint directional arrows as well as lane lines on the pavement.

Neither Van Maren (3) nor Radwan (2) conducted any research as to the advantages of specific types of signal locations on visibility. However, several countermeasures were evaluated by the computer simulation model. These countermeasures included the provision of an advance warning system through rumble strips and the reduction of amber duration to 2 seconds. The simulation results showed no reduction in rearend and right angle conflicts, but the number of left turn conflicts was reduced with the provision of rumble strips on U.S. 41 (see Table 9-4).

Conclusion

This intersection has had a very serious accident history. The large number of rearend accidents on all approaches to the intersection indicates that drivers are not prepared to stop, either for the signal when it changes or for vehicles ahead which do stop for the signal. Our recommendations are to install the signals in a box configuration, provide overhead advance warning signs on U.S. 41, and to install advance warning signs on 45th Avenue in each direction.

Figure 9-1.



U.S. 41

TRUCKS →

189 1241 54

AUTOS →

1834 7875 1375



91 1488

133 2120

75 1197

83 42

2144 91

732 116

45th AVE.

NOTE: THESE VOLUMES
ARE PROJECTED 1977
ADTS.

3182 8954 647
216 1376 27

Figure 9-2.

VOLUME DIAGRAM (ADT)
LAKE COUNTY
Intersection of:
U.S. 41 and 45th AVE.

Table 9-1.

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, In
Lake County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: LaPorte

TOTAL ACCIDENTS
37

*1 NOT RECORDED

DAY	DARK
24	12

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	28		13	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
21	9		L=1 R=1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4			1

ROAD CONDITION				*1 NOT RECORDED
DRY	WET	SNOW/ICE	OTHER	
24	9	3		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	4	7	3	7	5	8

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1		1							3	1	4	10
PM	3	2	2	3	2	7	1	1			2	4	27

Table 9-2.

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, IN
Lake County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: LaPorte

TOTAL ACCIDENTS
40

DAY	DARK
29	11

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	31		14	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
18	4	2	L= 9 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
32	5	3	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	7	8	6	3	6	7

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1						2	1	3	6	2	2	17
PM	2	2	1	1	3	1	1	4	2	2	2	1	22

Table 9-3.

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, IN
Lake County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: LaPorte

TOTAL ACCIDENTS	DAY	DARK
29	20	9

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
8	21		14	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
12	1		L= 11 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
18	7	4	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	2	7	5	4	3	5

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		1	2				1	1	1	3		2	11
PM	1	3	1		1	6		2	2		2		18

Table 9-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at U.S. 41 at 45th Avenue Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	0.07	1	116
Advance Warning System (rumble strips)	0.08	1	99
Reduce Amber Duration	0.09	1	108

SITE NO. 10

U.S. 31 and Kern Road Intersection

Description of U.S. 31 and Kern Road Intersection

The intersection of U.S. 31 and Kern Road is located in St. Joseph County in the LaPorte district of the Indiana State Highway Commission. U.S. 31 is a four-lane highway with a four foot painted median. Kern Road is a two-lane highway with right turn lanes at the intersection. The intersection is controlled by a fixed-time signal with a left-turn phase for southbound U.S. 31 vehicles turning onto eastbound Kern Road.

There has been a total of 86 accidents at the intersection during the three year study period, including 49 personal injuries.

Evaluation of the Intersection

The evaluation of this intersection was made by an analysis of the written comments of the team members, with a concensus drawn from these comments.

Predominant Accident Type - Rearend

Primary Cause - Drivers not anticipating traffic signal.

Concensus Countermeasure - Additional warning on U.S. 31.

Other Possible Causes - Traffic signals not sufficiently visible.

Other Possible Countermeasures - Reduce speed limit on U.S. 31, longer amber phase in signal, relocate signal heads over land lines.

Other Accident Types - Left Turning Movement

Possible Causes - Large volumes of turning vehicles, shadow effect for northbound to westbound turning vehicles.

Possible Countermeasures - Provide left-turn bays on U.S. 31, widen and offset left turn lanes on U.S. 31, provide left-turn phase in signal for northbound U.S. 31 vehicles.

Van Maren's research (3) did not consider the size or number of advance warning signs at intersections.

The simulation model was used to evaluate two possible countermeasures. The first countermeasure included the provision of left turn bays for northbound traffic on U.S. 31, while the second countermeasure represented the provision of a left turn phase and bay for southbound traffic on U.S. 31. These countermeasures did not indicate any reduction in rearend and right angle conflicts, but the provision of left turn phase and bay for southbound traffic significantly reduced the number of left turn conflicts (see Table 10-4).

Conclusion

The majority of the accidents at this location have been rearend accidents, but the left-turning movement accidents have also been significant. Our recommendations are to provide an overhead advance warning sign on each U.S. 31 approach, with flashers, and to include a left-turn phase in the signal for northbound U.S. 31 traffic.

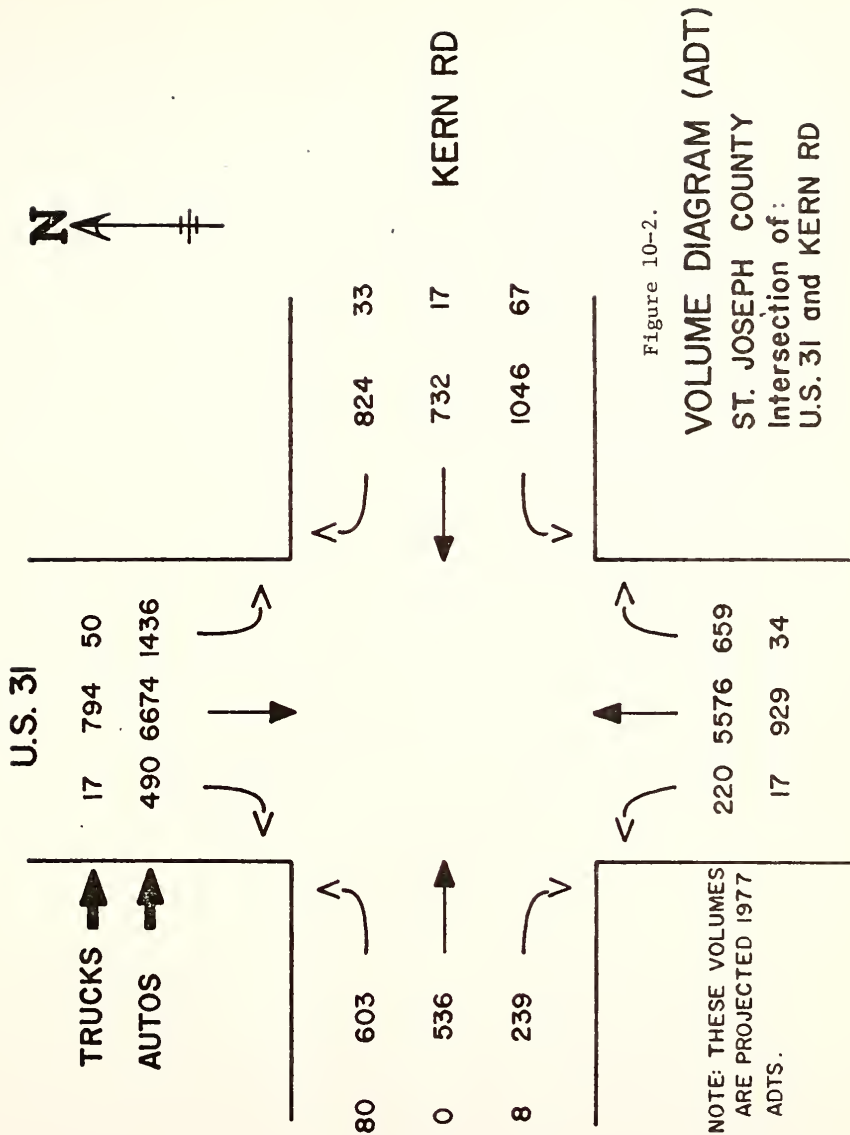


Table 10-2.

ACCIDENT

SUMMARY

LOCATION: US 31 at Kern Rd.

St. Joseph County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: LaPorte

TOTAL
ACCIDENTS

30

DAY

DARK

25

5

PERSONAL
INJURY

14

PROPERTY
DAMAGE

16

FATAL

INJURED

24

KILLED

REAR END

11

RIGHT ANGLE

5

OUT OF
CONTROL

4

TURNING
MOVEMENT

L= 9 R=

SIDE SWIPE

1

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

20

WET

7

SNOW/ICE

3

OTHER

SUN.

4

MON.

7

TUES.

3

WED.

1

THUR.

4

FRI.

2

SAT.

9

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1						1		1	2		3	8
PM	2	5	3	3	4	1		1	1	1	1		22

Table 10-3.

ACCIDENT

SUMMARY

LOCATION: US 31 at Kern Rd.

St. Joseph County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: LaPorte

TOTAL
ACCIDENTS

25

DAY

22

DARK

3

PERSONAL
INJURY

4

PROPERTY
DAMAGE

21

FATAL

INJURED

5

KILLED

REAR END

17

RIGHT ANGLE

3

OUT OF
CONTROLTURNING
MOVEMENT

L= 4 R=

SIDE SWIPE

1

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

15

WET

3

SNOW/ICE

7

OTHER

SUN.

1

MON.

1

TUES.

4

WED.

1

THUR.

8

FRI.

7

SAT.

3

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM				1							1	2	4
PM	3	2	7	1	4	2	1	1					21

Table 10-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at U.S. 31 at Kern Road Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	16.63	6	58
Provide Left Turn Phase (N-bound)	5.98	9	56
Provide Left Turn Bay in addition to Left Turn Phase (S-bound)	15.52	12	47

SITE NO. 11

U.S. 31 and S.R. 38 Intersection

Description of the U.S. 31 and S.R. 38 Intersection

The intersection of U.S. 31 and S.R. 38 is in Hamilton County in the Greenfield District of the Indiana State Highway Commission. U.S. 31 is a four-lane divided highway with left-turn lanes, and S.R. 38 is a two-lane highway intersecting U.S. 31 at a 57° skew.

The intersection is controlled by continuous flasher operation, with stop signs on S.R. 38 and yield signs in the median.

Traffic volumes on U.S. 31 are approximately 7000 vehicles per day in each direction, with approximately 1500 vehicles per day in each direction on S.R. 38. Turning movements are relatively light.

There have been 46 accidents at the intersection during the study period, with 40 injuries and one fatality.

Evaluation of the Intersection

The Indianapolis team discussed this intersection at a team meeting, and formed a team consensus as to the accident types, causes and countermeasures.

Predominant Accident Type - Right Angle

Primary Cause - Poor visibility of the intersection.

Possible Countermeasures - Reduction of grades on U.S. 31, activate flasher at intersection from 6:00 a.m. to 9:00 p.m., increase advance warning distance and install flashers on these signs, enlarge lens size on the flashers, install strobe lights in the flashers, and double the flashing signal heads.

Other Accident Types - Rearend

Possible Cause - Wide speed distribution of speed on U.S. 31 caused by vehicles turning right.

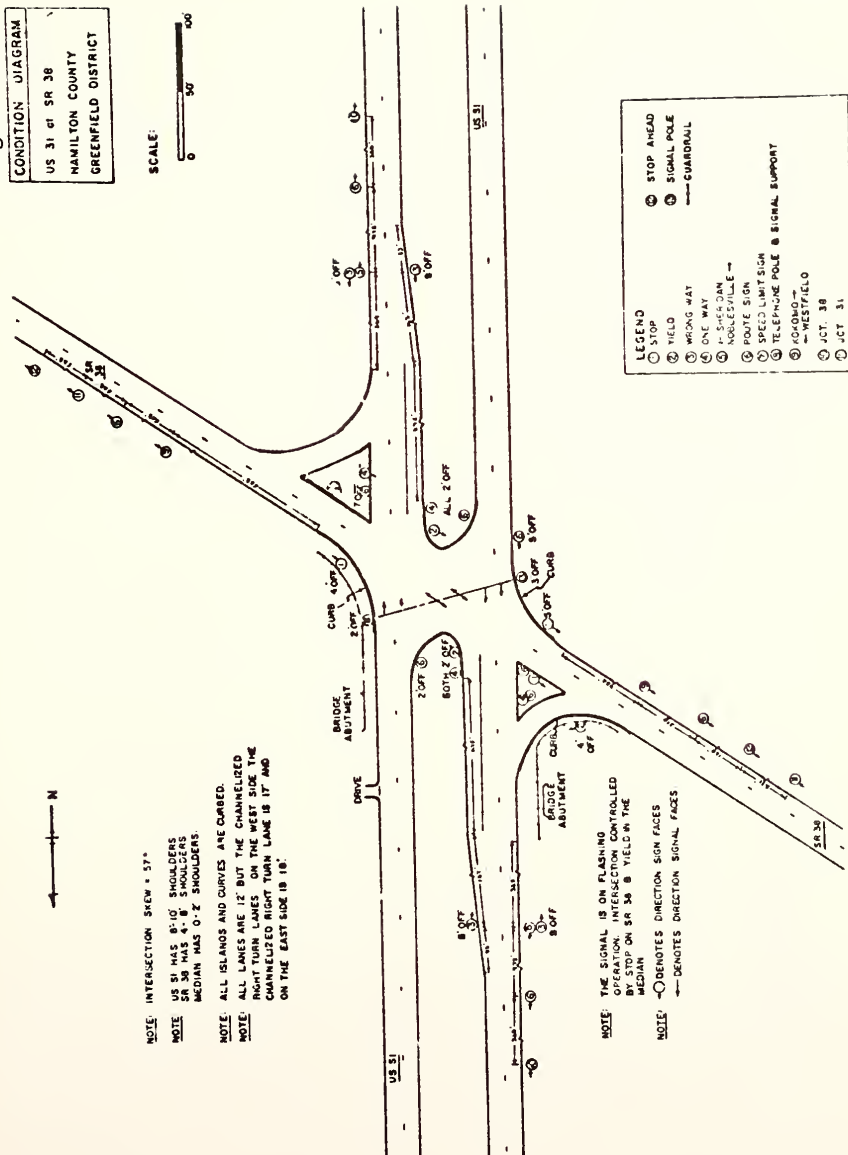
Possible Countermeasures - Installation of right-turn lanes on U.S. 31, elimination of curbs in the four quadrants of the intersection.

The following countermeasures were incorporated in simulation runs and the results were evaluated with respect to the existing condition: 1) installation of strobe lights on advance warning on S.R. 38, 2) addition of a right turn lane on U.S. 31, and 3) reduction of grade on U.S. 31. The results indicated that all of these countermeasures would reduce rearend and right angle conflicts (Table 11-4). The installation of strobe lights on advance warning signs on S.R. 38 and the reduction of grade on U.S. 31 would be most effective, as these two countermeasures would also reduce left turn conflicts to a certain extent.

Conclusion

Both the right angle accidents and the rearend accidents are significant at this intersection. Van Maren's research (3) showed a high correlation between skew of roadways and accident rates, but total reconstruction of the intersection to eliminate the skew is impractical, as is reconstruction to reduce the grades on U.S. 31. Our recommendations are to increase the advance warning distance on U.S. 31 by installing strobe lights in the intersection flasher as well as to install strobe lights on advance warning signs on S.R. 38.

Figure 11-1.



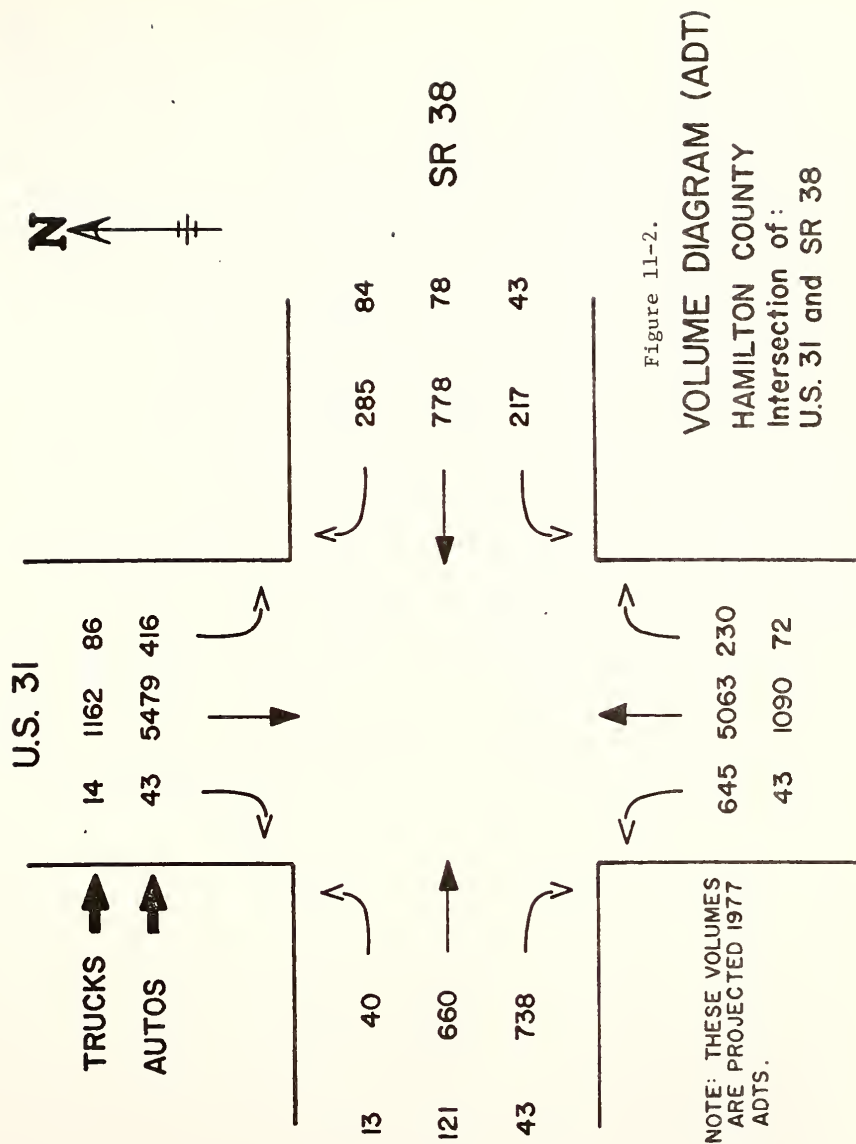


Table 11-1.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 38

Hamilton County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL
ACCIDENTS

11

DAY

DARK

11

PERSONAL
INJURY

3

PROPERTY
DAMAGE

8

FATAL

INJURED

8

KILLED

REAR END

1

RIGHT ANGLE

4

OUT OF
CONTROL

4

TURNING
MOVEMENT

L= 1 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

9

WET

1

SNOW/ICE

1

OTHER

SUN.

MON.

TUES.

2

WED.

1

THUR.

4

FRI.

2

SAT.

2

TIME FACTOR

12-1

1-2

2-3

3-4

4-5

5-6

6-7

7-8

8-9

9-10

10-11

11-12

TOTAL

AM

1

1

PM

2

1

2

3

1

1

10

Table 11-2.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 38

Hamilton County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield District

TOTAL
ACCIDENTS

22

DAY

21

DARK

1

PERSONAL
INJURY

9

PROPERTY
DAMAGE

12

FATAL

1

INJURED

20

KILLED

1

REAR END

9

RIGHT ANGLE

4

OUT OF
CONTROL

4

TURNING
MOVEMENT

L= 5 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

14

WET

1

SNOW/ICE

7

OTHER

SUN.

3

MON.

5

TUES.

1

WED.

1

THUR.

5

FRI.

3

SAT.

4

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								2		3		1	6
PM	1		4		4	1	3	1			1	1	16

Table 11-3.

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 38

Hamilton County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS
13

DAY	DARK
7	6

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
7	6		12	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
4	6		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
8	1	4	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	4	1			4	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	3							1	3				7
PM			1	1	1		1	1	1				6

Table 11-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Three Suggested Countermeasures at U.S. 31 - S.R. 38 Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	6.85	13	44
Install Strobe on Warning Sign at S.R. 38	7.00	2	42
Construct Right-Turn Lane at U.S. 31	12.02	10	47
Reduce Grade on U.S. 31	4.16	5	41

SITE NO. 12

U.S. 40 and Round Barn Road Intersection

Description of U.S. 40 and Round Barn Road Intersection

The intersection of U.S. 40 and Round Barn Road is located in Wayne County in the Greenfield District of the Indiana State Highway Commission, in an area which changes rapidly from rural to heavy commercial development. U.S. 40 is a four-lane undivided highway with a right turn lane on the west leg. Round Barn Road is a narrow two-lane road. The intersection is controlled by a traffic signal actuated by traffic on Round Barn Road.

Traffic volumes at the intersection are high, with volumes on U.S. 40 approximately 9000 vehicles per day in each direction, and approximately 1150 vehicles per day in each direction on Round Barn Road. Turning movements are quite heavy, especially to and from the south leg of Round Barn Road.

The accident history at this intersection shows a total of 35 accidents during the three-year study period, with thirteen personal injuries and no fatalities.

Evaluation of the Intersection

The intersection was evaluated by an analysis of written comments of the various team members who studied the intersection, with the consensus of those comments shown below.

Predominant Accident Type - Left Turn

Primary Cause - Insufficient gaps in U.S. 40 traffic.

Consensus Countermeasure - Left turn bays on U.S. 40, combined with a separate left turn phase in the signal.

The team felt that the combination of relatively high speeds and volumes on U.S. 40, coupled with the fact that vehicles waiting to turn left block an entire through lane, contribute to a feeling of anxiety in the turning motorists, which in turn leads them to accept gaps which are not sufficient.

Other Possible Causes - Speed of vehicles on U.S. 40.

Other Possible Countermeasures - Reduce the speed limit, enforcement of the speed limit, overhead sign over the left lane of U.S. 40 designating through and left-turn movements.

Other Accident Types

The other accident types were insignificant at this intersection.

Van Maren's research (3) shows that the presence of a left-turn lane on the major road correlates with a reduction in the accident rate.

The computer simulation model was used to evaluate the following countermeasures: 1) addition of a left turn bay on U.S. 40, 2) addition of left turn phase, and 3) reduction of speed on U.S. 40 from 50 to 40 mph. The comparison of results of countermeasures with those from existing conditions indicated no reduction in the number of conflicts in all categories (see Table 12-4).

Conclusion

This section of U.S. 40 carries relatively high volumes of traffic at high speeds, and the left-turn lane, the high speed lane, serves the dual function of through and left turn movements. Vehicles stopped in the left lane on the green awaiting gaps in the opposing traffic in order to complete their turning movement are in an extremely vulnerable position.

According to one of the team members, lack of available right-of-way and the necessity to relocate utilities would make widening of the highway to provide a separate left-turn lane in each direction very difficult and expensive. Nevertheless, because virtually all of the accidents at this location are left-turning movement or rearend accidents on U.S. 40, our recommendation is to provide separate left-turn lanes on U.S. 40 in each direction, and left-turn phases in the signal.

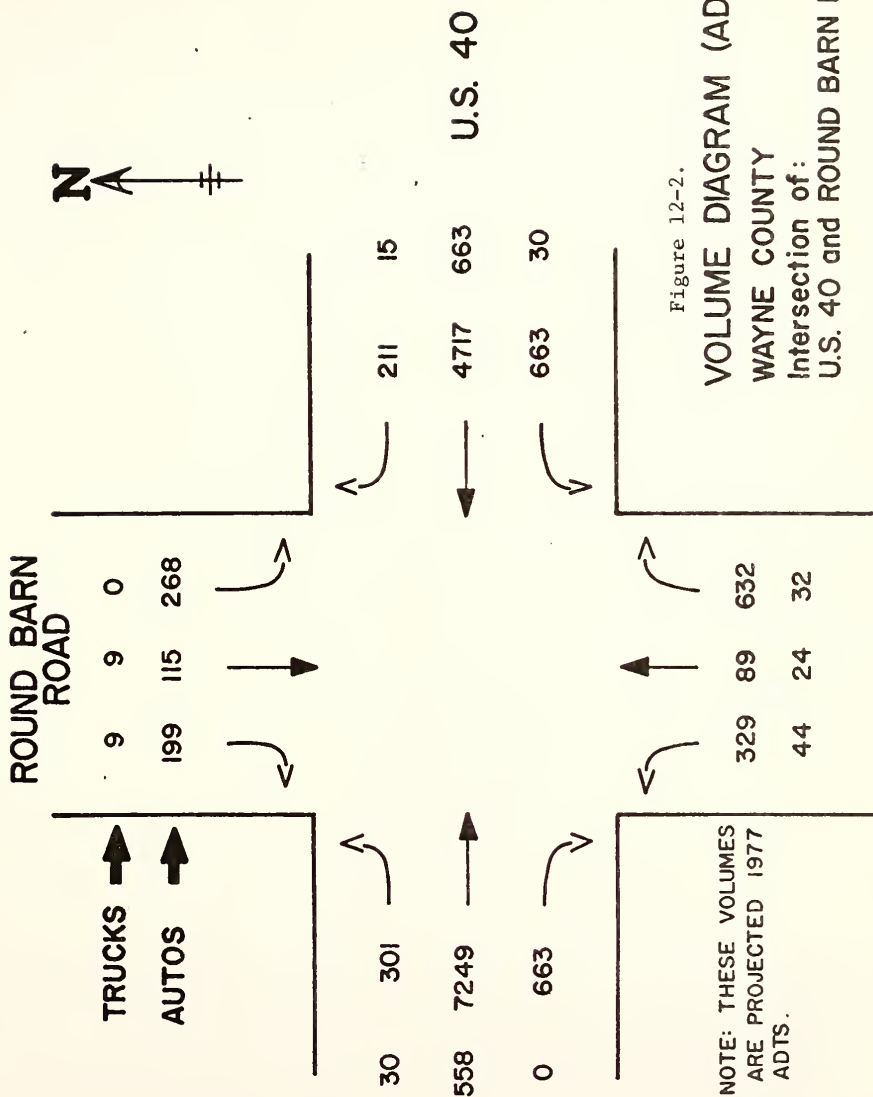


Figure 12-3.

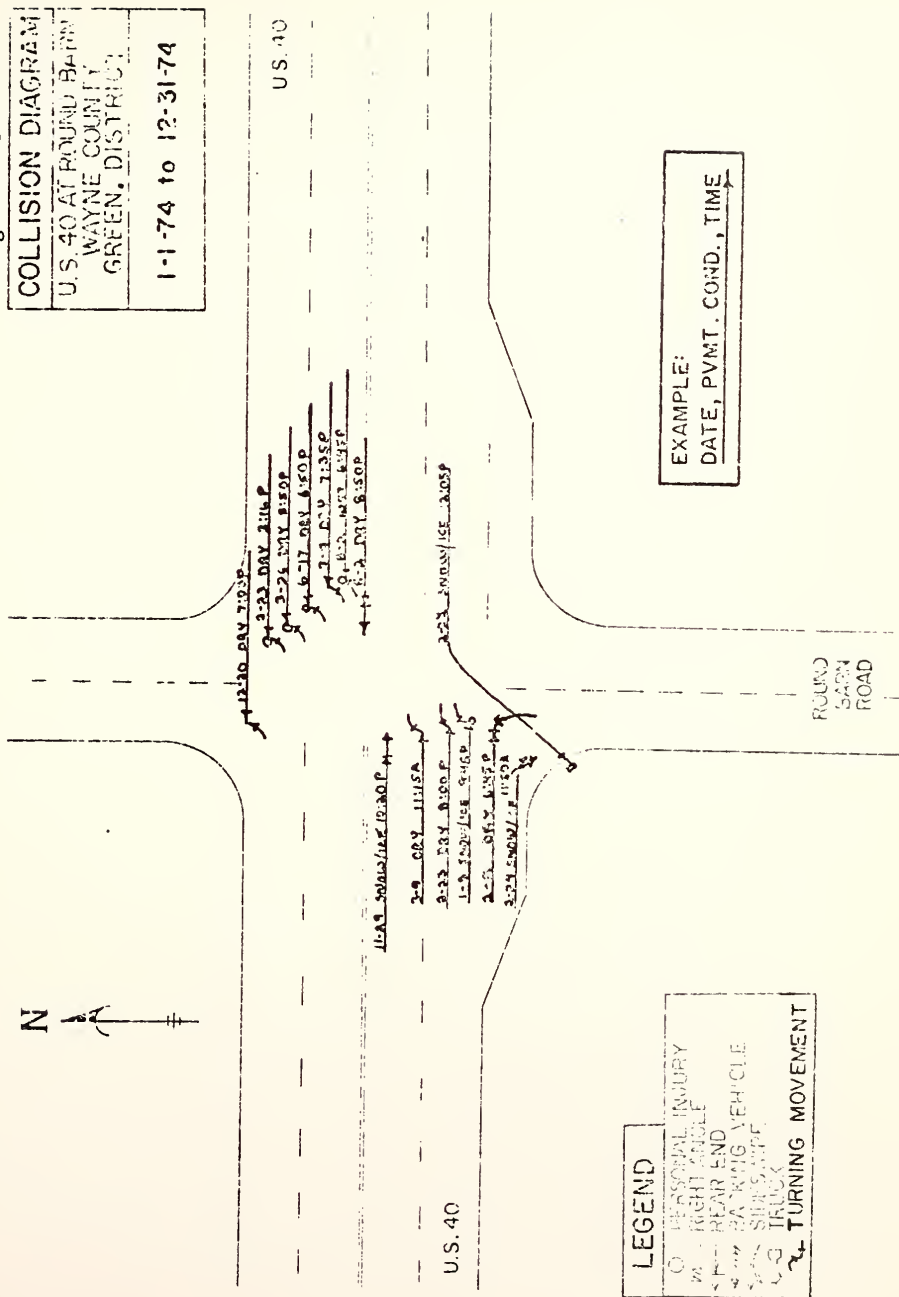


Figure 12-4.

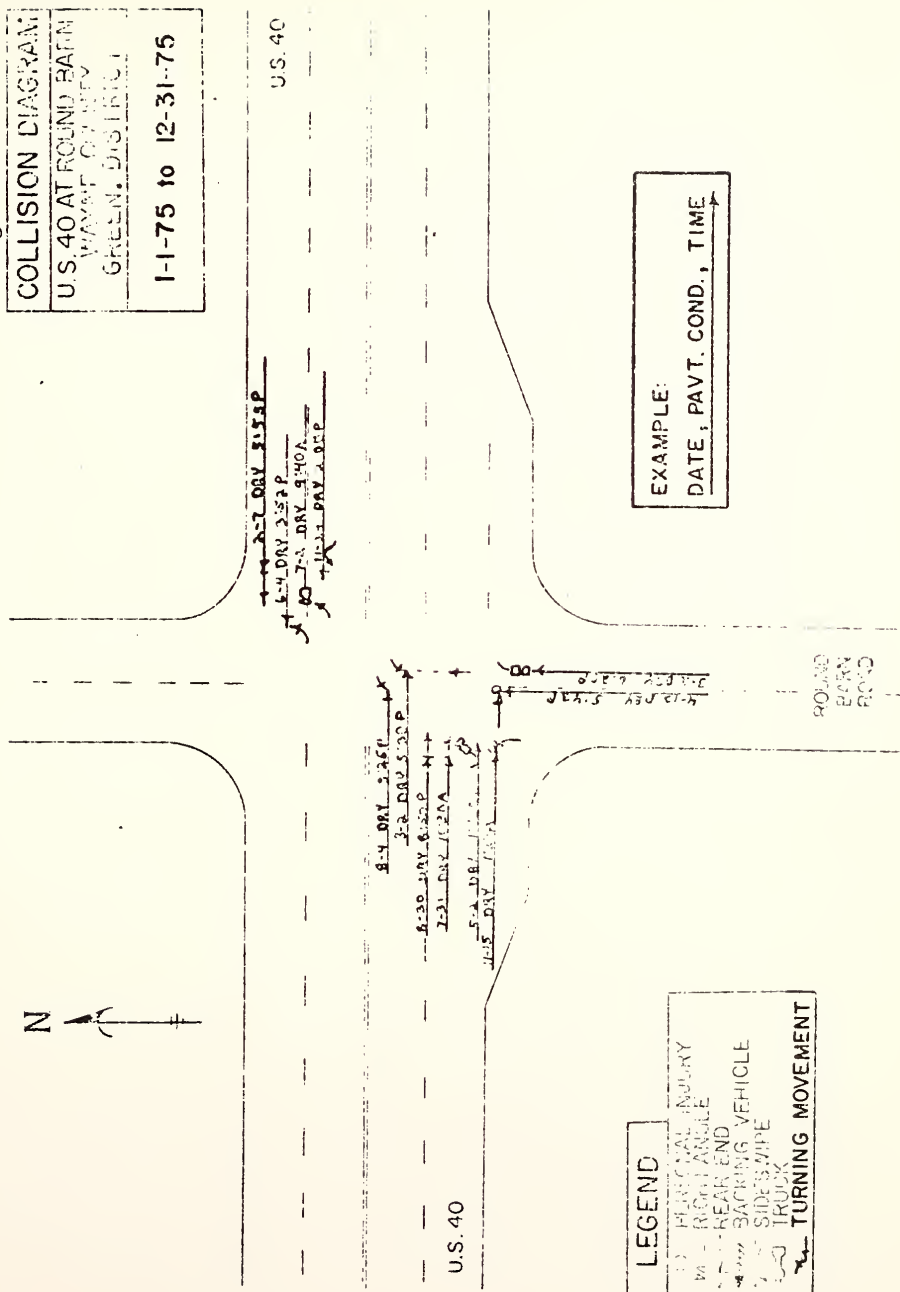


Table 12-1

ACCIDENT

SUMMARY

LOCATION:	US 40 at Round Barn Rd.
	Wayne County
PERIOD:	1-1-74 to 12-31-74
DISTRICT:	Greenfield District

TOTAL ACCIDENTS	DAY	DARK
14	8	6

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
5	9		9	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3			L= 11 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
9	1	4	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1	3			4	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM												2	2
PM	1			2			3	2	2	1	1		12

Table 12-2.

ACCIDENT

SUMMARY

LOCATION: US 40 at Round Barn Rd.
Wayne County
PERIOD: 1-1-75 to 12-31-75
DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
12	10	2

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
2	10		3	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3	1		L= 5 R= 1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
2			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
12			

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	2		2	1	2	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1		1	2		4
PM			1	1		3	1		2				8

Table 12-3.

ACCIDENT

SUMMARY

LOCATION: US 40 at Round Barn Rd.

Wayne County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL
ACCIDENTS

9

DAY

8

DARK

1

PERSONAL
INJURY

1

PROPERTY
DAMAGE

8

FATAL

INJURED

1

KILLED

REAR END

1

RIGHT ANGLE

OUT OF
CONTROLTURNING
MOVEMENT

L= 7 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

7

WET

2

SNOW/ICE

OTHER

SUN.

MON.

3

TUES.

WED.

1

THUR.

1

FRI.

4

SAT.

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM													
PM	1		3	1	1		2				1		9

Table 12-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Three Suggested Countermeasures at U.S. 40 at Round Barn Road Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	4.55	9	12
Add a Left Turn Bay	3.34	8	13
Add a Left Turn Phase	2.98	9	11
Reduce Speed on Major	2.90	7	11

SITE NO. 13

U.S. 31 and National Avenue Intersection

Description of U.S. 31 and National Avenue Intersection

The intersection of U.S. 31 and National Avenue is in Marion County in the Greenfield District of the Indiana State Highway Commission. U.S. 31 is a six-lane undivided highway and National Avenue is a two-lane street with right turn lanes at the intersection. The intersection is controlled by a fixed-time signal.

The traffic volume of U.S. 31 is approximately 14000-16000 vehicles per day in each direction, and that on National Avenue is 900-1200 vehicles per day in each direction.

There have been a total of 88 accidents at this intersection during the study period, with 58 personal injuries.

Evaluation of the Intersection

The Indianapolis team discussed this intersection at a team meeting, and a team consensus was reached regarding the predominant accident types, causes and countermeasures.

Predominant Accident Type - Left-Turning Movement

Primary Cause - Left turning drivers on U.S. 31 accepting insufficient gaps.

Countermeasures - Install overhead signs with lane usage designations to supplement pavement markings on U.S. 31, construct opposing left-turn bays on U.S. 31, add left-turn phase to traffic signal if warranted.

Other Possible Causes - Poor signal visibility.

Other Possible Countermeasures - Reduce parking near U.S. 31, eliminate driveway near the intersection on National Avenue.

Other Accident Types

The other accident types were insignificant at this intersection.

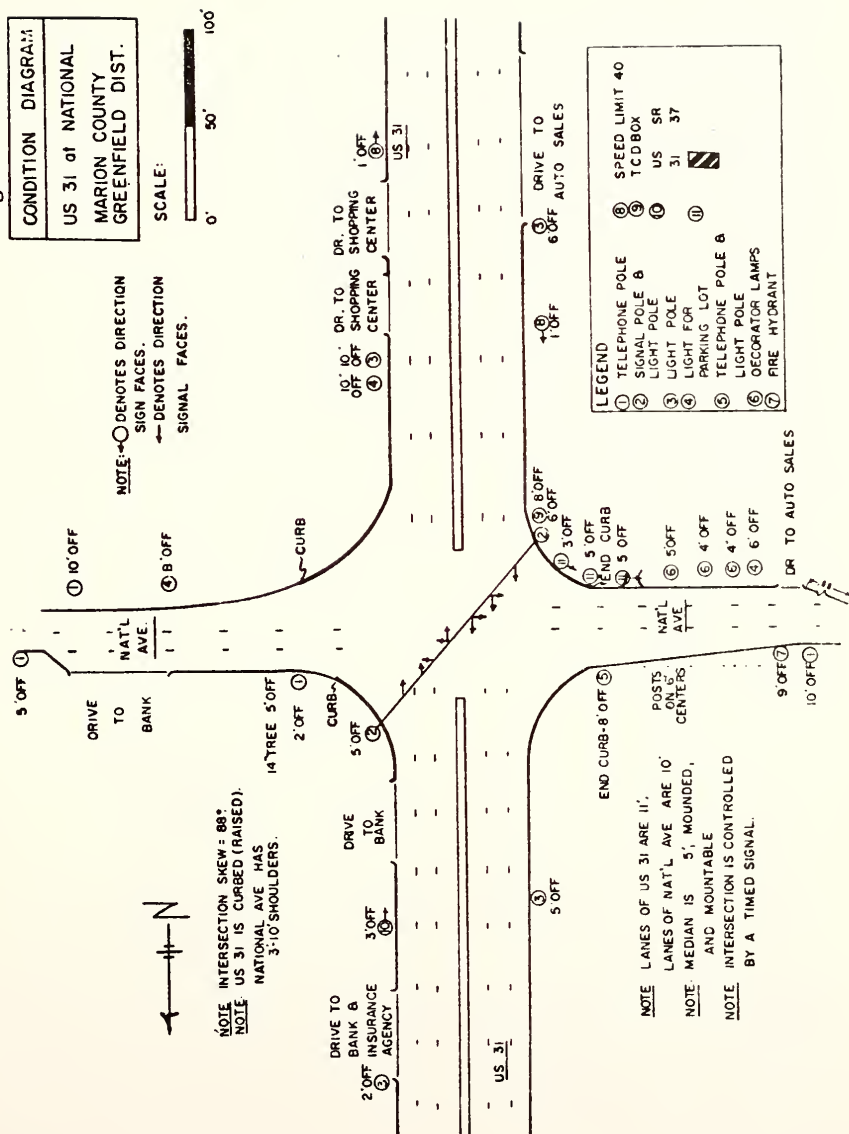
The computer simulation model was used to evaluate two countermeasures:

1) addition of left turn bays on U.S. 31 and 2) addition of left turn phase to traffic signal. Although both of these countermeasures significantly reduced rearend and right angle conflicts, left turn conflicts were reduced only under the addition of left turn phase (Table 13-4).

Conclusion

This intersection has had a poor accident history, with the majority of the accidents involving U.S. 31 vehicles turning left. Most of the remaining accidents have been rearend accidents on U.S. 31. Our recommendations are to install overhead signs on U.S. 31 with lane use designations, and to conduct a signal timing study to determine if left-turn phases are warranted at this intersection.

Figure 13-1.



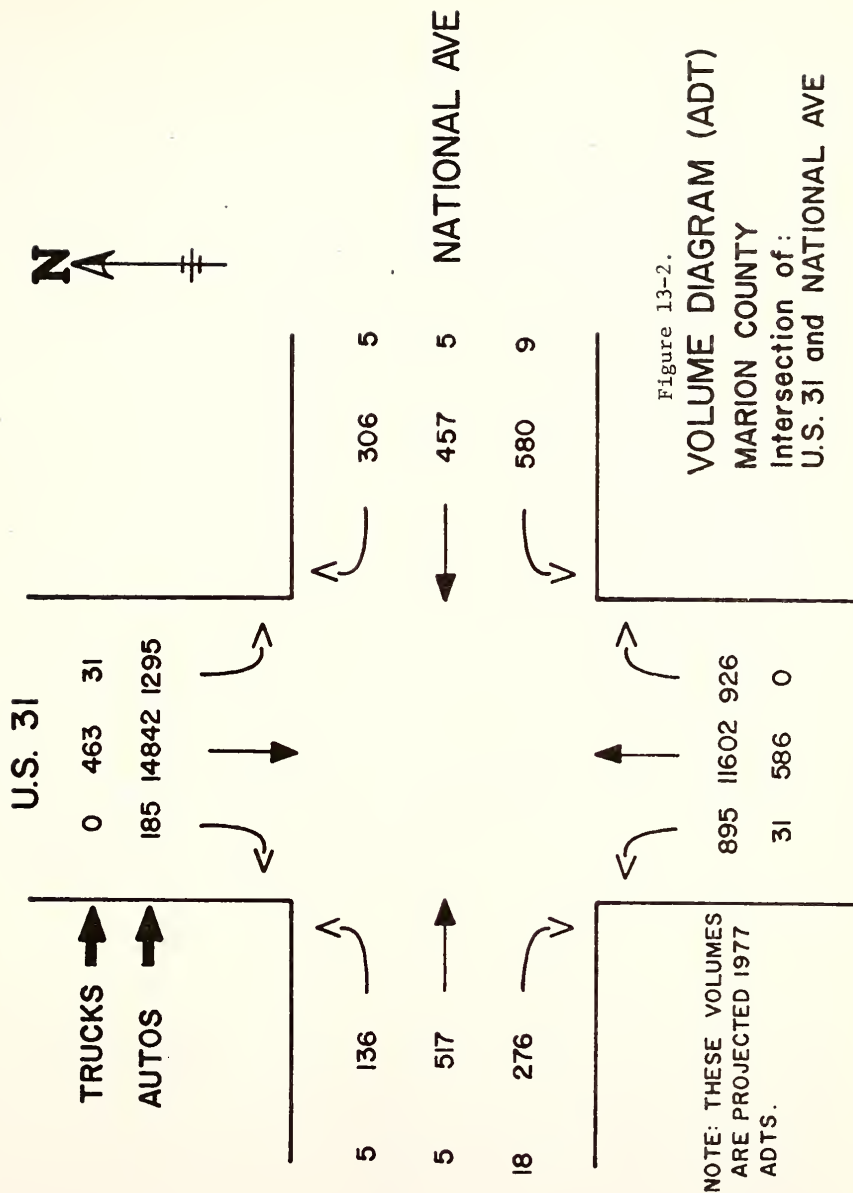


Table 13-1.

ACCIDENT

SUMMARY

LOCATION:	US 31 at National Avenue
	Marion County
PERIOD:	1-1-74 to 12-31-74
DISTRICT:	Greenfield

TOTAL ACCIDENTS	DAY	DARK
30	22	8

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
13	17		26	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	1		L= 22 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
25	4	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	3	6	6	2	8	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1					1			2	1		1	6
PM	3	4	2	3	1	2	1	4	3		1		24

Table 13-2.

ACCIDENT

SUMMARY

LOCATION: US 31 at National Avenue

Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL
ACCIDENTS

38

DAY

32

DARK

6

PERSONAL
INJURY

16

PROPERTY
DAMAGE

22

FATAL

INJURED

28

KILLED

REAR END

12

RIGHT ANGLE

2

OUT OF
CONTROL

1

TURNING
MOVEMENT

L= 19 R=

SIDE SWIPE

3

HEAD-ON

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

28

WET

9

SNOW/ICE

1

OTHER

SUN.

4

MON.

2

TUES.

4

WED.

6

THUR.

5

FRI.

8

SAT.

9

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM										2	2	7	11
PM	2	5	6	3	1	4	2		1	1	2		27

Table 13-3.

ACCIDENT

SUMMARY

LOCATION:	US 31 at National Avenue
	Marion County
PERIOD:	1-1-76 to 12-31-76
DISTRICT:	Greenfield

TOTAL ACCIDENTS	DAY	DARK
20	17	3

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
3	17		4	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3	2	1	L= 13 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
18	2		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	2	4	2	2	4	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1	2	1	2	6
PM	2	2	3	1	3		1			1	1		14

Table 13-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at U.S. 31 at National Road Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	8.78	11	48
Add a Left Turn Pocket	8.39	6	67
Add a Left Turn Phase	14.72	7	20

SITE NO. 14

S.R. 67 and Franklin Road Intersection

Description of the S.R. 67 and Franklin Road Intersection

The intersection of S.R. 67 and Franklin Road is in Marion County in the Greenfield District of the Indiana State Highway Commission. S.R. 67 is a four-lane undivided highway with left-turn bays at the intersection. The north approach of Franklin Road is a four-lane suburban street, and the south approach is a two-lane street with a right-turn lane at the intersection. The skew at the intersection is 59°.

The intersection is controlled by a fixed-time signal, and the traffic volumes are heavy, with S.R. 67 carrying approximately 15000-19000 vehicles per day in each direction, and approximately 8000 vehicles per day in each direction on Franklin Road. Turning movements are high at the intersection.

There have been 146 accidents at this intersection during the three-year study period, with one fatality and 45 injuries.

Evaluation of the Intersection

The Indianapolis team discussed this intersection at a team meeting, with the following consensus as to accident types, causes and countermeasures.

Predominant Accident Type - Left-Turning Movement

Primary Cause - High volumes of traffic on S.R. 67.

Consensus Countermeasure - None.

Other Possible Causes - Poor signal visibility, too much driveway access.

Other Possible Countermeasures - Install traffic signals in a box configuration, widen Franklin Road, paint lane lines on pavement.

The computer simulation model was used to generate information on possible conflicts resulting from the existing condition which were then compared with the results using the following three countermeasures:

- 1) addition of a left turn phase, 2) addition of an all-red phase, and
- 3) increase of amber duration. The results indicated that although all

of these countermeasures reduced left turn conflicts only the addition of an all-red phase would reduce rearend and right angle conflicts. The addition of a left turn phase considerably reduced the left turn conflicts (see Table 14-4).

Conclusion

Although the results of the team meeting did not indicate it, both rearend and right-angle accidents are very significant at this intersection in addition to the left-turning movement accidents discussed. This intersection has the highest accident frequency of the eighteen intersections included in this study. Our recommendations are to provide overhead advance warning signs with flashers on all approaches to the intersection, and to conduct a complete signal timing study to determine what type of signal system would be best for this dangerous, high-volume intersection.

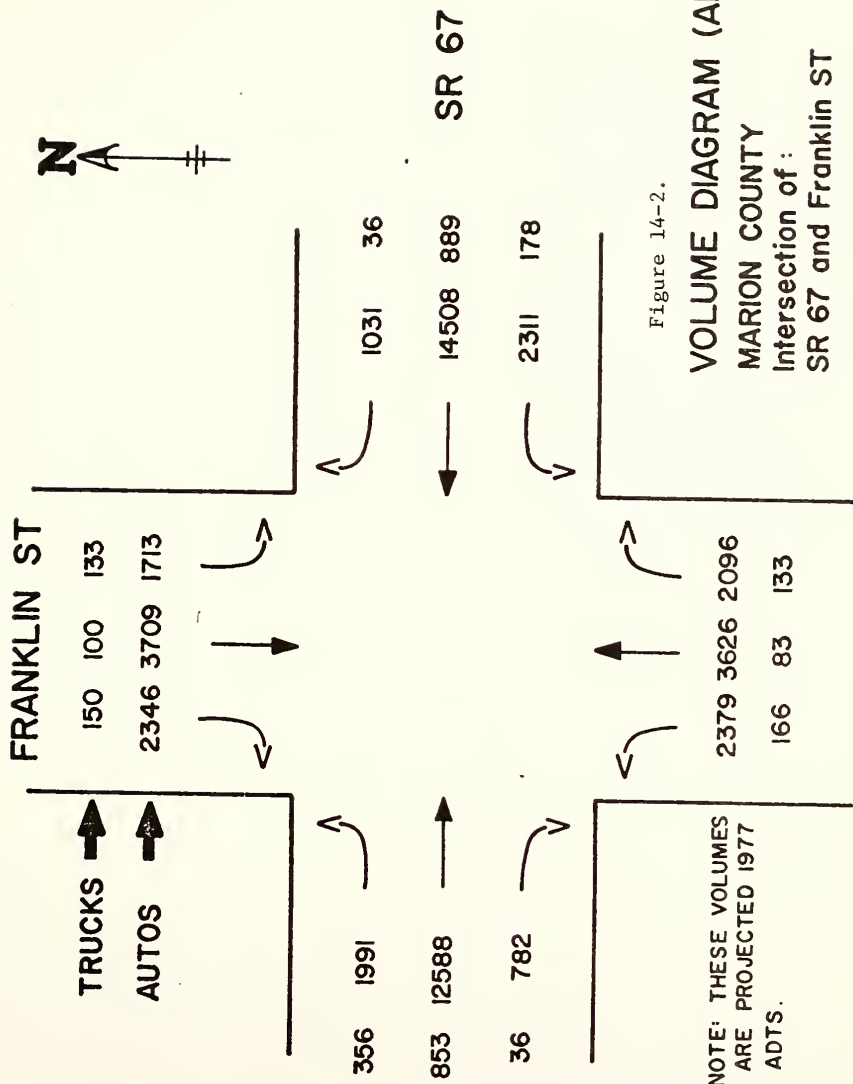
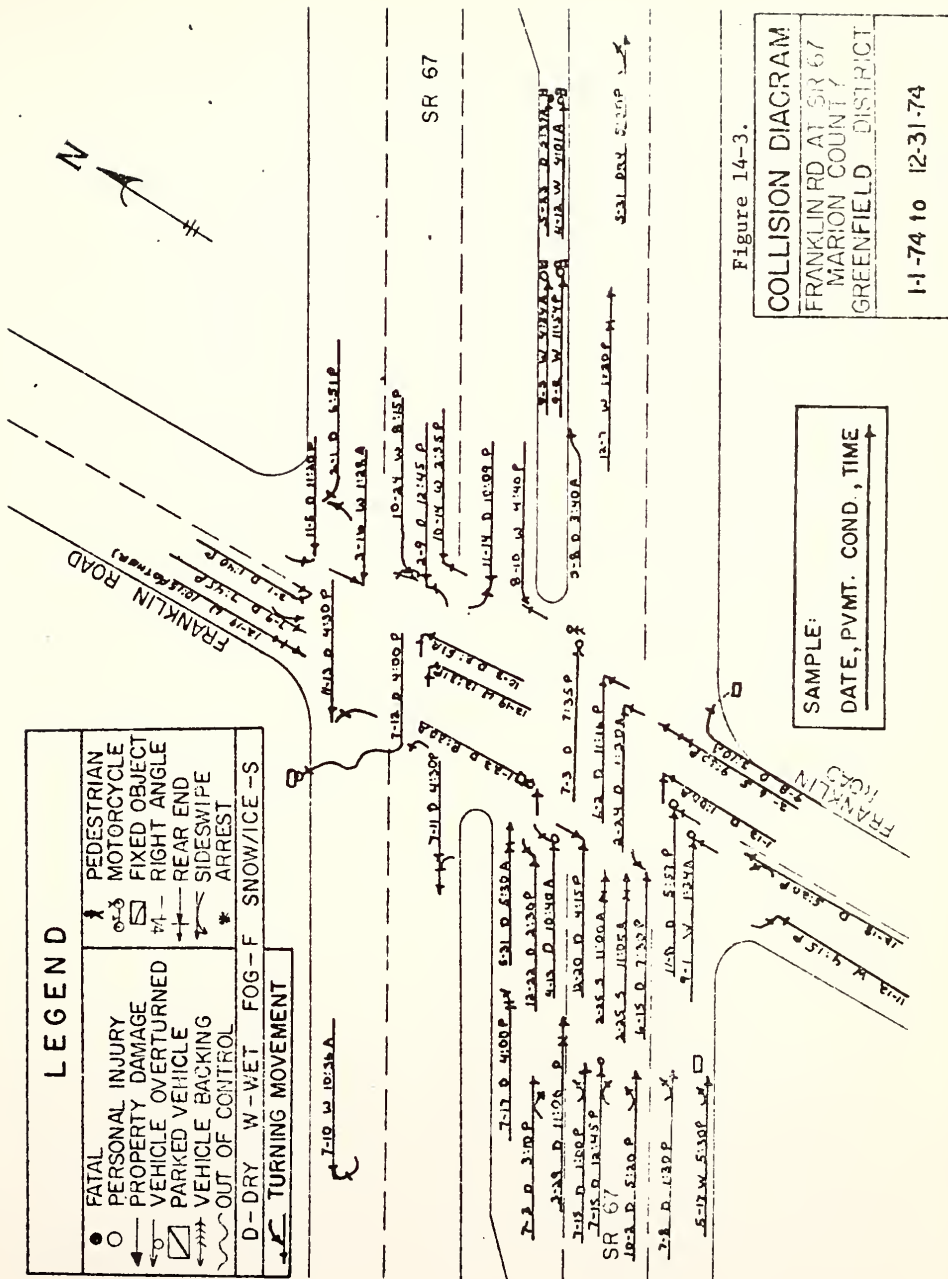
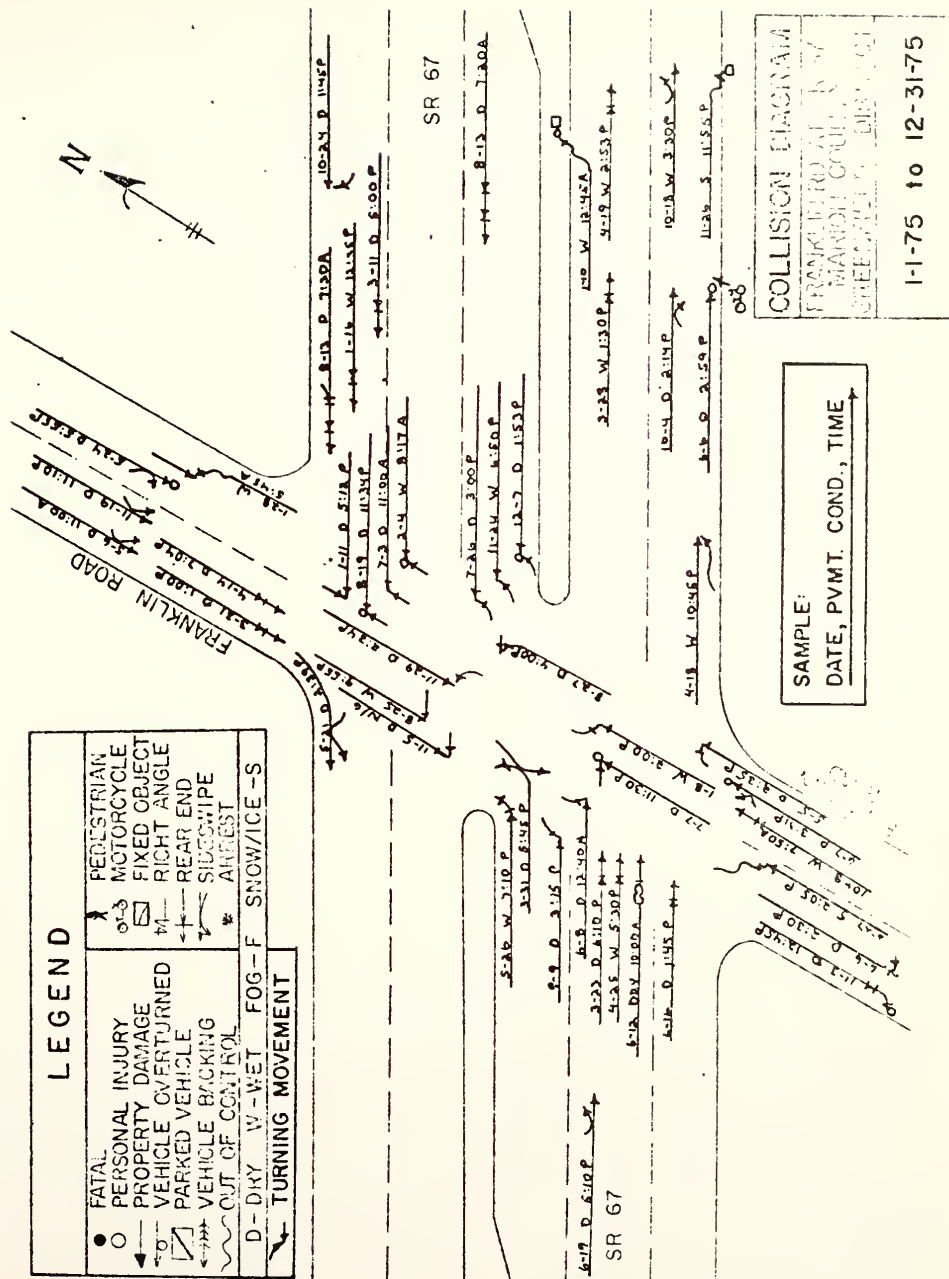


Figure 14-2.





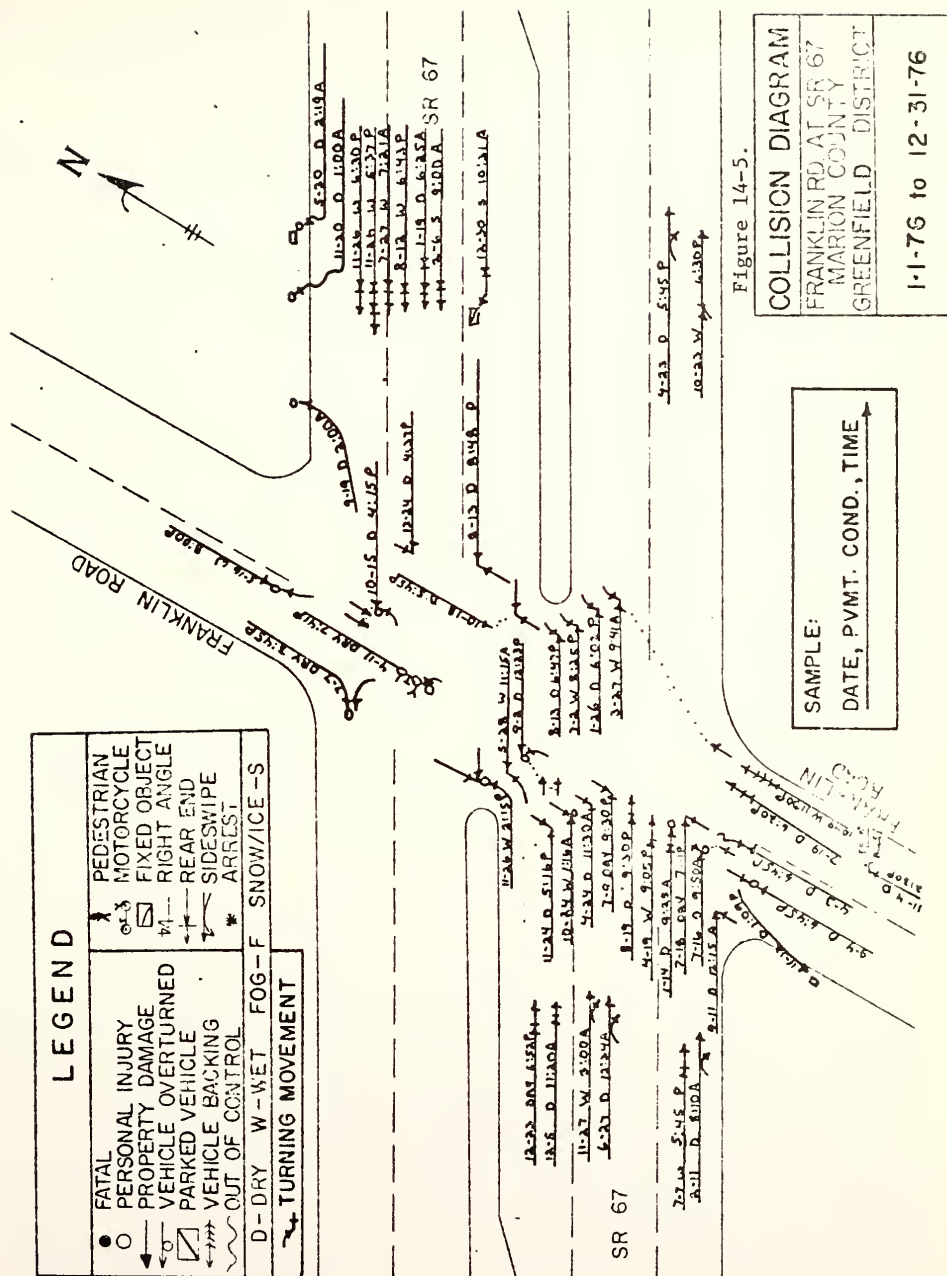


Table 14-1.

ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL
ACCIDENTS

50

DAY

29

DARK

21

PERSONAL
INJURY

10

PROPERTY
DAMAGE

39

FATAL

1

INJURED

19

KILLED

1

REAR END

5

RIGHT ANGLE

8

OUT OF
CONTROL

1

TURNING
MOVEMENT

L= 16 R= 2

SIDE SWIPE

10

HEAD-ON

PEDESTRIAN

1

OTHER

7

ROAD CONDITION

DRY

33

WET

14

SNOW/ICE

3

OTHER

SUN.

6

MON.

7

TUES.

4

WED.

9

THUR.

7

FRI.

11

SAT.

6

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		4	2	2	2	1			1		2	2	16
PM	3	4	1	2	7	5	1	3	1	1	2	4	34

Table 14-2.

ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
48	39	9

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	39		10	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
14	9	3	L= 9 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
9			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
32	14	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	10	6	9	5	7	8

TIME FACTOR 1 NOT GIVEN													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	2					1		3	1		1	2	10
PM	2	5	9	4	1	6	2	2		1	1	4	37

Table 14-3.

ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
48	28	20

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
11	37		16	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
14	11	2	L= 11 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4	2		4

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
31	15	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
8	5	2	5	6	14	8

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	2	2	2	2			1	1	1	4	1	3	19
PM	1	1	2	1	2	5	8	2	3	3		1	29

Table 14-4. Stop Delay per Vehicle, Number of Conflicts and Left-Turn Conflicts for Existing Condition and Three Suggested Countermeasures at S.R. 67 at Franklin Road Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	15.07	19	162
Add a Left Turn Phase	63.91	20	115
Add All-Red Phase	27.90	13	154
Increase Amber Duration	20.69	21	157

SITE NO. 15E

Northeast Junction of S.R. 67 and I-465,
East Intersection

Description of the East Intersection, Northeast Junction,
of S.R. 67 and I-465

The east intersection at the northeast junction of S.R. 67 and I-465 is the intersection of S.R. 67 with the northbound on and off ramps of I-465, located in Marion County in the Greenfield district of the Indiana State Highway Commission. S.R. 67 west of the intersection is a six-lane divided highway, with a left turn lane to the I-465 on-ramp. East of the intersection S.R. 67 is a channelized six-lane highway including a right turn lane onto the northbound ramp. The off-ramp from northbound I-465 is two lanes, with two additional right turn lanes onto eastbound S.R. 67, controlled by a yield sign for those lanes. The intersection is controlled by an actuated traffic signal.

The traffic volumes are extremely high, with approximately 18000-22000 vehicles per day in each direction on S.R. 67, and 8000 vehicles per day using the off-ramp. There are approximately 5200 turning movements per day onto the northbound I-465 on-ramp.

There has been a total of 73 accidents at this intersection during the three year study period, including 29 personal injuries.

Evaluation of the Intersection

The intersection was evaluated by an analysis of the written comments of the team members, with a consensus drawn from these comments.

Predominant Accident Type - Rearend

Primary Cause - Lack of visibility of the signal.

Consensus Countermeasure - No consensus. The team members felt that the intersection is simply overloaded, and that a complete reconstruction was about the only way to solve the problem.

Other Possible Causes - Close proximity of the intersection to 42nd Street, turns into and out of 42nd Street, excessive speed on S.R. 67, insufficient clearance time, insufficient capacity of the intersection, lack of lane control, poor signal timing.

Other Possible Countermeasures - Enlarge signal lenses, install a strobe light in the signal, enforce the speed limits, increase the amber signal phase, increase the left turn phase, provide lane markings, provide progressive signal timing.

Other Accident Types

The other accident types were insignificant at this intersection.

The countermeasures tested with the computer simulation model are:

1) installation of strobe lights as advance warning on S.R. 67, 2) restriction of all left turns on arrow only, and 3) installation of an all-red phase. The results indicated no change in rearend and right angle conflicts. However, the left turn conflicts were reduced considerably with the installation of strobe lights on S.R. 67 as well as with the restriction of all left turns on arrow only (see Table 15E-4).

Conclusion

Several of the team members noted the fact that the number of accidents was considerably less in the third year of the study period, from 29 and 31 accidents the first two years to only 13 accidents the third year. Either changes were made in the intersection during the study period which brought about a reduction in the accident rate, or drivers became more familiar with the operation of the intersection. Our recommendation is that no changes be made in the intersection at this time, but that the accident history be carefully observed in the future.

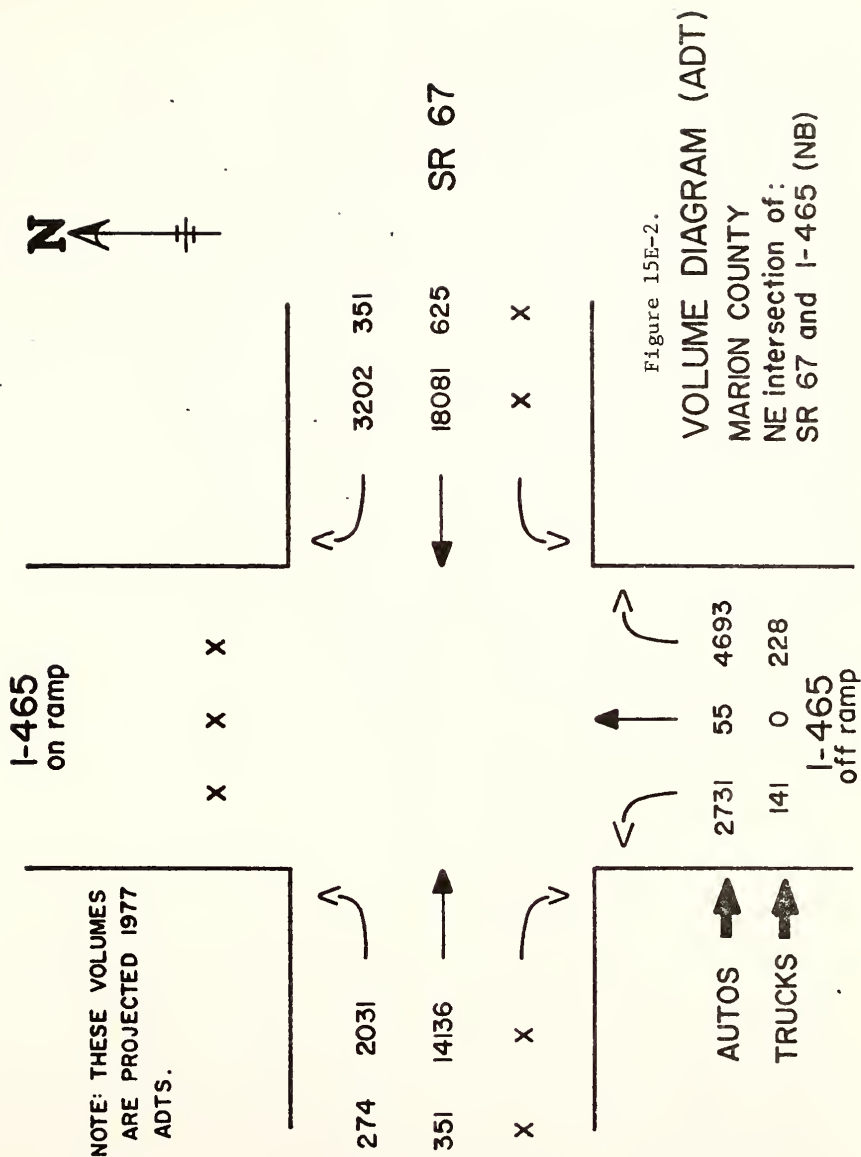


Table 15E-1.

ACCIDENT

SUMMARY

LOCATION: N-Bound I-465 at SR 67 - NE Junction -
E. intersection of the interchange
Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS
29

DAY	DARK
21	8

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
8	21		12	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
19	2		L= 4 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
18	9	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	4	5	1	4	6	7

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM					1				3		1		5
PM	1	1	3	2	4	4	1	1	3		2	2	24

Table 15E-2.

ACCIDENT

SUMMARY

LOCATION: N-Bound I-465 at SR 67 - NE Junction -
E. intersection of the interchange
Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS
31

DAY	DARK
21	10

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	22		10	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
14	2	2	L= 6 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
6			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
26	3	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	4	3	1	6	11	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		2					1	3	2	2	1	1	12
PM	1		2		5	4		1	2	3		1	19

Table 15E-3.

ACCIDENT

SUMMARY

LOCATION: N-Bound I-465 at SR 67 - NE Junction -
E. intersection of the interchange
Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
13	7	6

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
6	7		7	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
7			L= 6 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
12	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
	2	2	2		2	5

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM			1		1			1	1			1	5
PM			1	1	1	1	1				1	2	8

Table 15E-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Three Suggested Countermeasures at S.R. 67 - I-465 NE at East Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	0.17	3	85
Install Strobe on Major Rd.	0.22	2	76
All Left Turn on Arrow Only	0.17	3	68
Install an All-Red Phase	0.16	3	88

SITE NO. 15W

Northeast Junction of S.R. 67 and I-465,
West Intersection

Description of the West Intersection, Northeast Junction,
of S.R. 67 and I-465

The west intersection at the northeast junction of S.R. 67 and I-465 is the intersection of S.R. 67 with the southbound on and off ramps of I-465, located in Marion County in the Greenfield district of the Indiana State Highway Commission. S.R. 67 is a six-lane divided highway with left and right turn lanes to the southbound on-ramp of I-465. The off-ramp from I-465 is a three-lane highway, including a right turn lane onto westbound S.R. 67, controlled by a yield sign for that lane. The intersection is controlled by an actuated traffic signal.

The traffic volumes at this intersection are quite high, with approximately 15000-17000 vehicles per day in each direction on S.R. 67. The off-ramp volume is approximately 6600 vehicles per day, and 8600 vehicles per day make turns from S.R. 67 onto the I-465 on-ramp.

The accident history at this intersection shows 58 accidents over the three year study period, with 30 personal injuries.

Evaluation of the Intersection

The intersection was evaluated by analyzing the written comments of the individual team members, and developing a consensus from the comments.

Predominant Accident Type - Rearend

Primary Cause - Lack of visibility of the signal.

Consensus Countermeasure - No consensus. Apparently reconstruction of the entire intersection is the team solution.

Other Possible Causes - Speed of vehicles on S.R. 67, lack of lane control.

Other Possible Countermeasures - Install near right traffic signal, install strobe light in traffic signal, enlarge signal lenses, reduce the speed limit on S.R. 67, enforce the speed limit, increase the amber phase in the signal, improve the pavement markings, provide a contrasting background for the traffic signals.

Other Accident Types - Left-Turning Movement

Possible Causes - Vehicles accepting insufficient gaps, insufficient intersection clearance time.

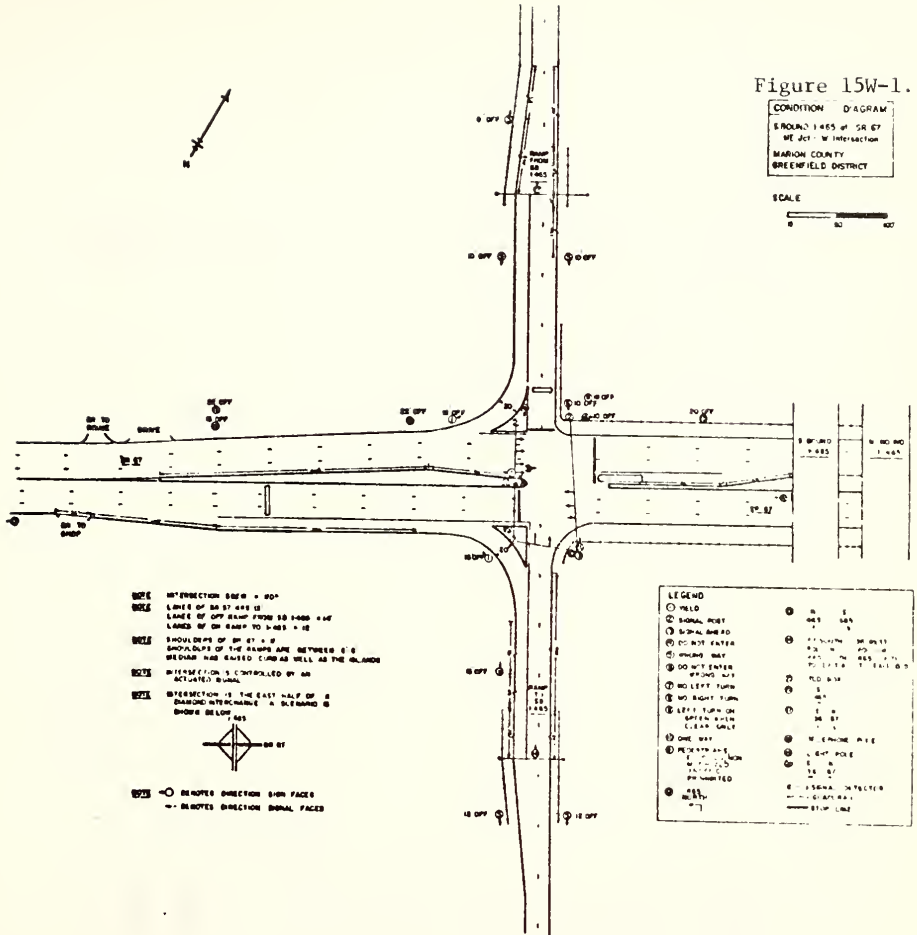
Possible Countermeasures - Provide a separate left-turn phase, increase the amber phase and/or all-red clearance phase.

Two countermeasures were evaluated with the computer simulation model. The first countermeasure was an increase of amber time to 7 seconds for S.R. 67 and to 5 seconds for the I-465 ramp, while the second was a reduction of speed on S.R. 67 to 40 mph. The simulation results did not show any reduction in the number of conflicts in all categories (see Table 15W-4).

Conclusion

As was the case with the east part of this interchange, the accident history here shows a significant decrease in the number of accidents during the third year of the study period, with a corresponding decrease in the number of personal injury accidents. Our recommendation is to improve signal visibility by the installation of near-right signals, and to monitor the future accident experience closely.

Figure 15W-1.



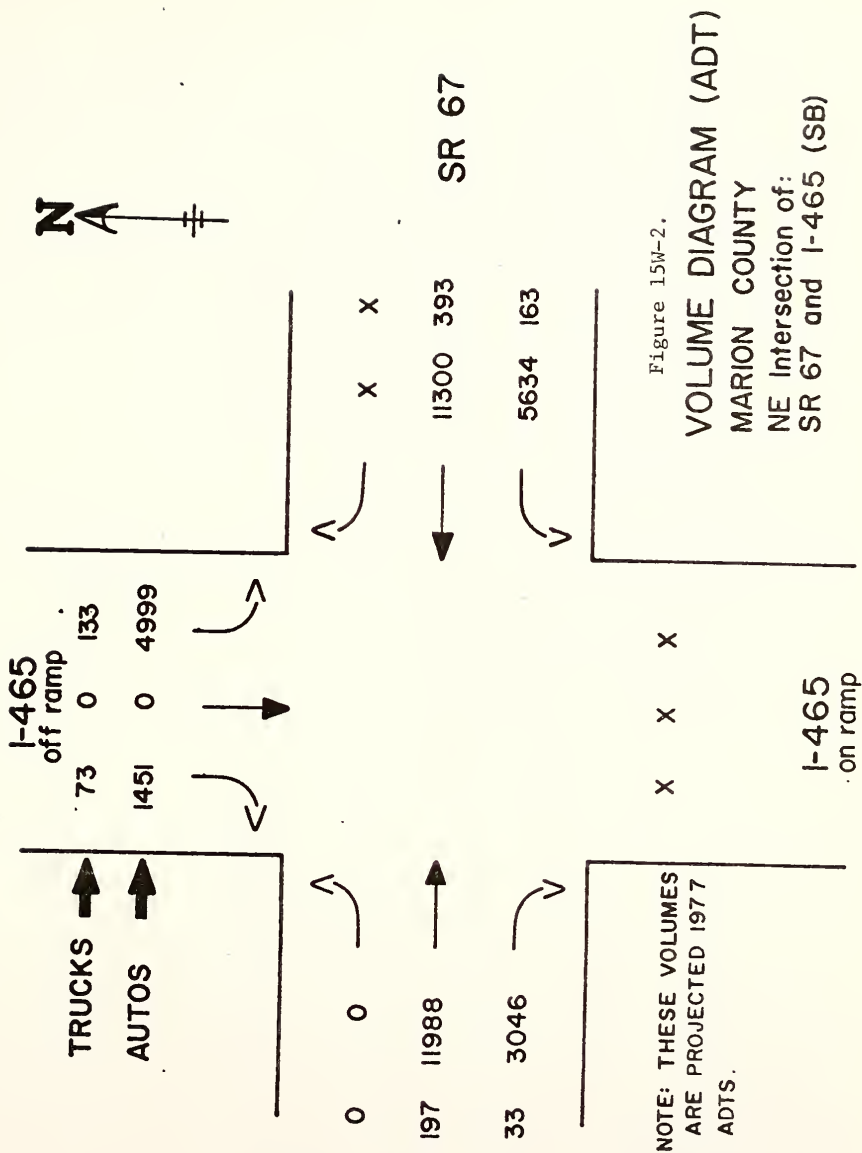


Table 15W-1.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - NE Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS
21

DAY	DARK
15	6

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
10	11		16	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
7	1		L= 8 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
14	6	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	1	4	2	2	2	7

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1							1	1	2		2	7
PM		1		2		2	2	2			1	4	14

Table 15W-2.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - NE Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
23	12	11

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
5	18		8	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
11	1	2	L= 6 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
13	7	3	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	3	2	3	4	6	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		2	1		1		1	1		1	2	2	11
PM	2		1		2	1	1	1	1	1		1	11

Table 15W-3.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - NE Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
14	10	4

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
3	11		6	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
6	2		L= 3 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
9	5		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1	1	3	2	4	1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM			1								1	1	3
PM	1		2	2	2	1	1			1		1	11

Table 15W-4. Stop Delay per Vehicle, Number of Conflicts, and Left-Turn Conflicts for Existing Condition and Two Suggested Countermeasures at S.R. 67 - I-465 NE at West Intersection

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	1.61	1	0
Increase Amber Time	1.55	1	3
Reduce Speed on Major	0.95	3	2

SITE NO. 16E

Southwest Junction of S.R. 67 and I-465,
East Intersection

Description of the East Intersection, Southwest Junction,
of S.R. 67 and I-465

The east intersection at the southwest junction of S.R. 67 and I-465 is the intersection of S.R. 67 and the on and off ramps to northbound I-465 located in Marion County in the Greenfield district of the Indiana State Highway Commission. S.R. 67 at the intersection is a six-lane divided highway with left and right turn lanes to the I-465 on ramp. The off ramp from northbound I-465 is two lanes with an additional right turn lane controlled by a yield sign. The intersection is controlled by stop signs for the off ramps.

The traffic volume on S.R. 67 is approximately 9000-12000 vehicles per day in each direction. Approximately 3000 vehicles per day use the off ramps, with approximately 7000 vehicles per day turning onto the on-ramp.

The accident history at the intersection shows a total of 37 accidents during the three-year study period, with 22 personal injuries.

Evaluation of the Intersection

The intersection was evaluated by an analysis of the written comments of the individual team members, with a consensus drawn from the comments.

Predominant Accident Type - Right Angle

Primary Cause - Off-ramp motorists accepting insufficient gaps in the S.R. 67 traffic.

Consensus Countermeasure - Install traffic signal.

Other Possible Causes - Inadequate advance warning on S.R. 67, excessive speed on S.R. 67.

Other Possible Countermeasures - Additional advance warning on S.R. 67, reduction of speed limit on S.R. 67.

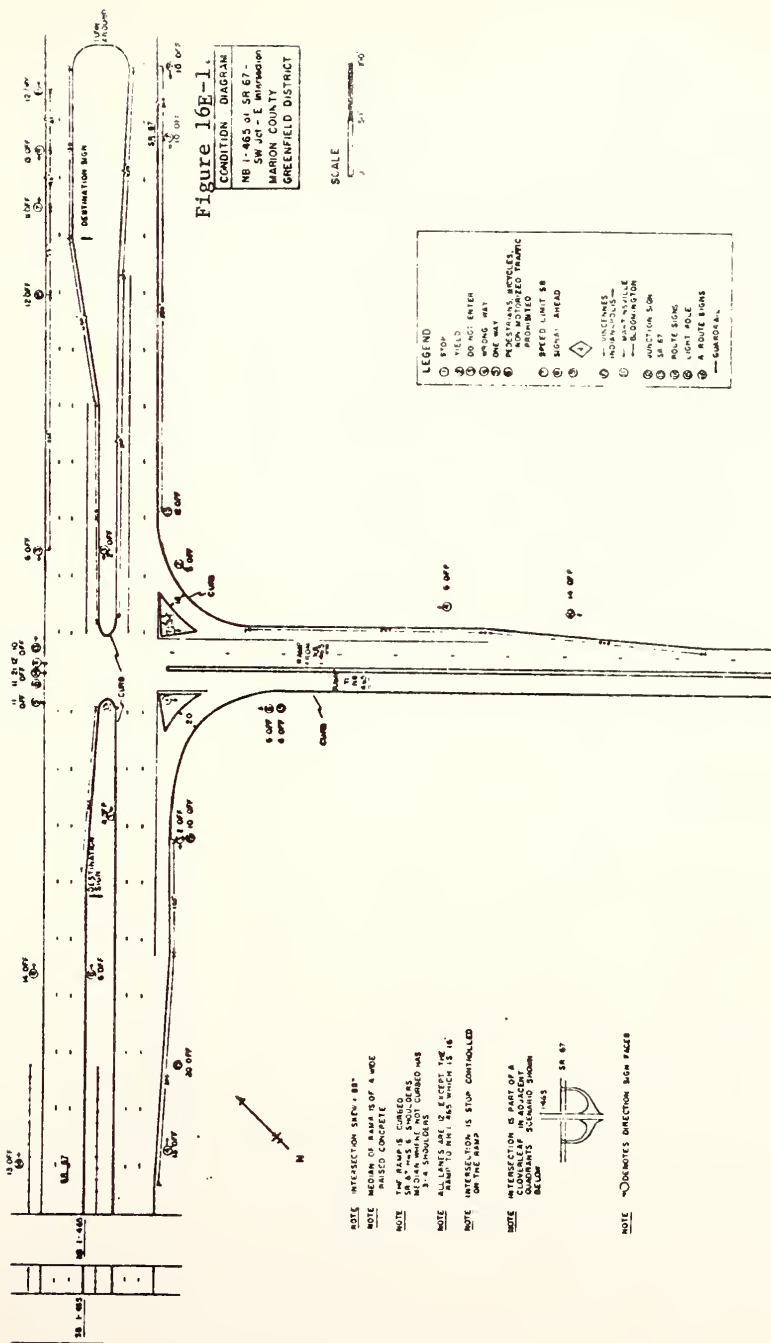
Other Accident Types - Rearend and Turning Movement

Other Causes and Countermeasures - Same as for predominant accident type.

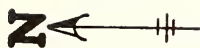
The results from two possible countermeasures were compared with those from simulating the existing condition. The first countermeasure involved the installation of an advance warning system on S.R. 67 while the second was a 10 mph reduction in speed on S.R. 67. It is assumed that this reduction would result from a speed enforcement program at this location. The advance warning system showed a considerable reduction in rear end and right angle conflicts, while the left turn conflicts did not show any change. The reduction of speed on S.R. 67 also reduced the number of left turn conflicts, although to a lesser extent (Table 16E-4).

Conclusion

The team consensus countermeasure for this intersection was that a traffic signal should be installed. Undoubtedly such installation would change the accident experience at this location. However, it is possible that a traffic signal would, in fact, cause an increase in the total number of accidents. The I-465 off-ramp intersection with S.R. 67 immediately west of this location is signalized and although the traffic volumes and patterns are somewhat different than at this location, definite similarities exist. There were eighteen more accidents and nine more personal injuries at the signalized intersection. The intersection should be evaluated, and if the warrants for a traffic signal exist, installation of a traffic signal should be made. Our recommendations, however, are to provide additional advance warning of the intersection on S.R. 67, and to reduce the speed limit on both S.R. 67 approaches to the intersection.







NOTE: THESE VOLUMES
ARE PROJECTED 1977
ADTS.

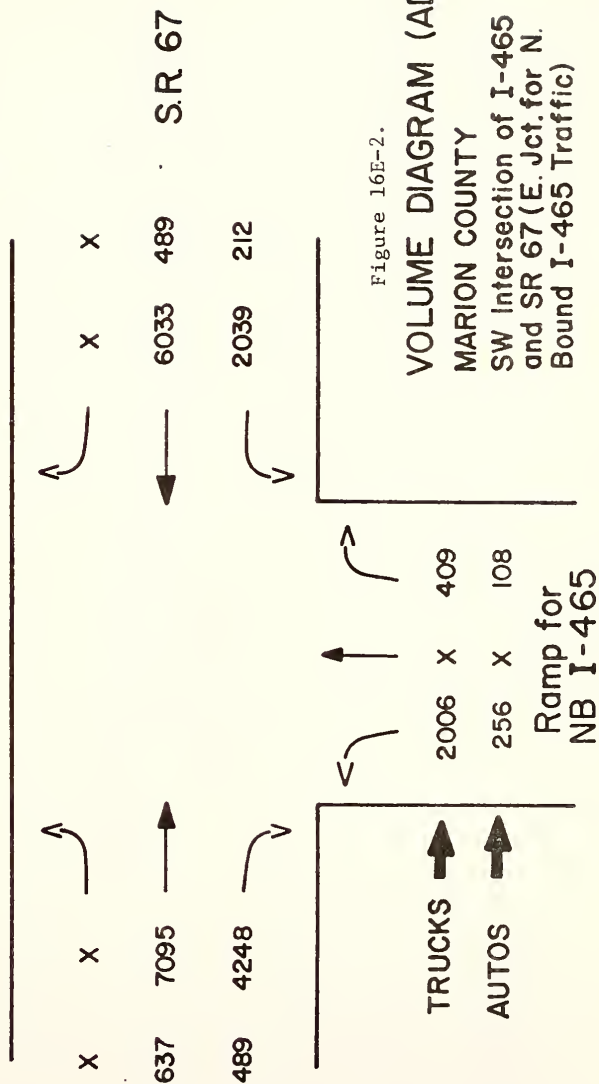
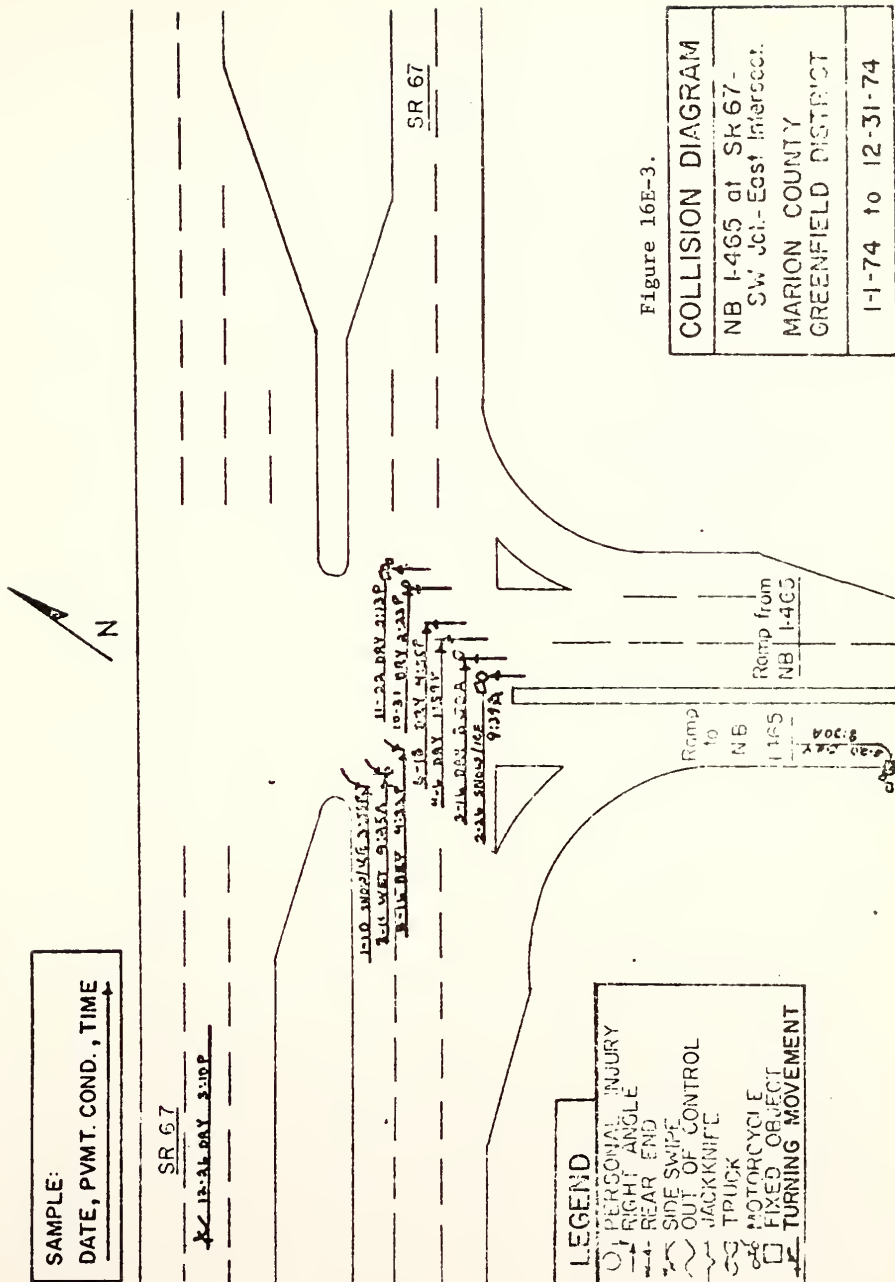
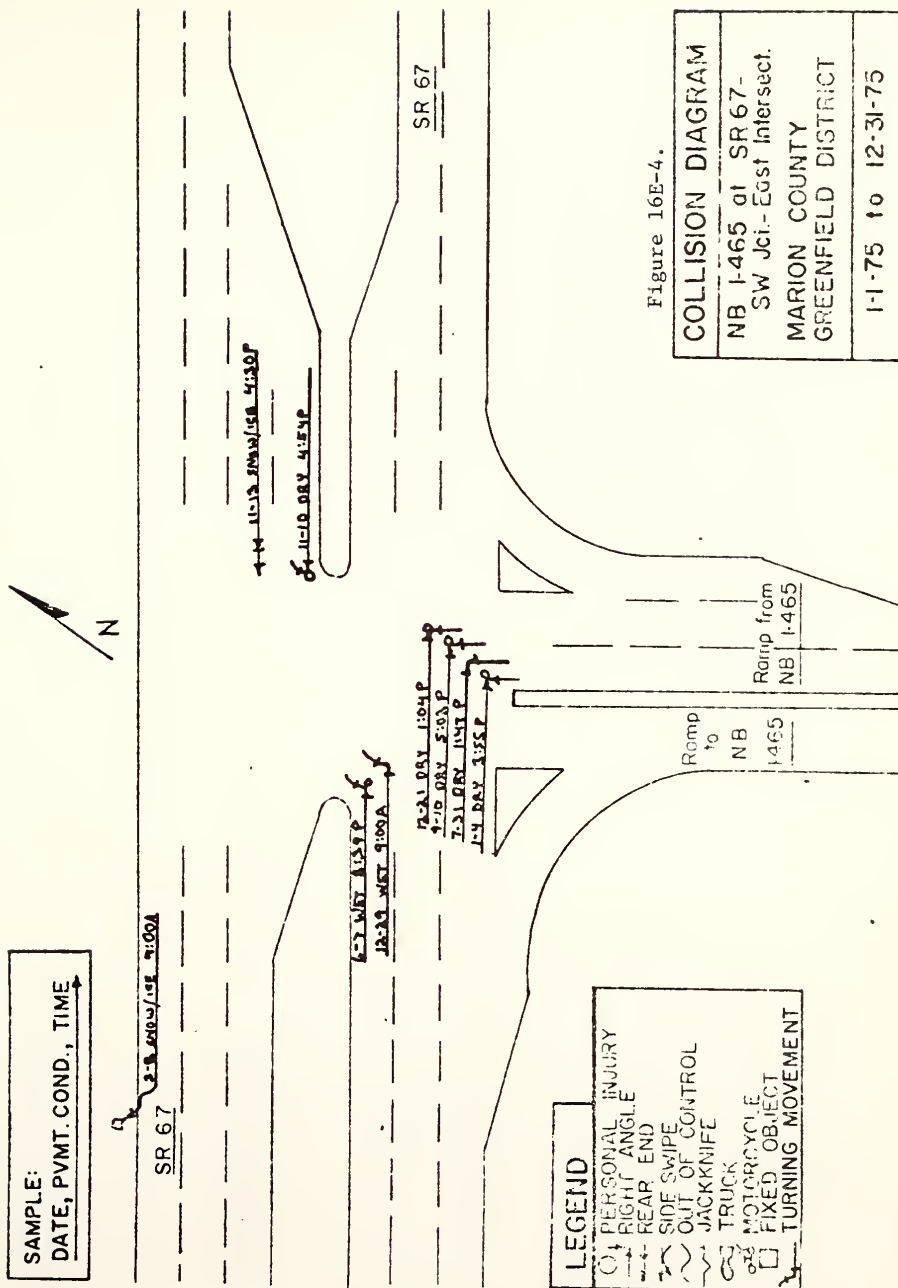


Figure 16E-2.





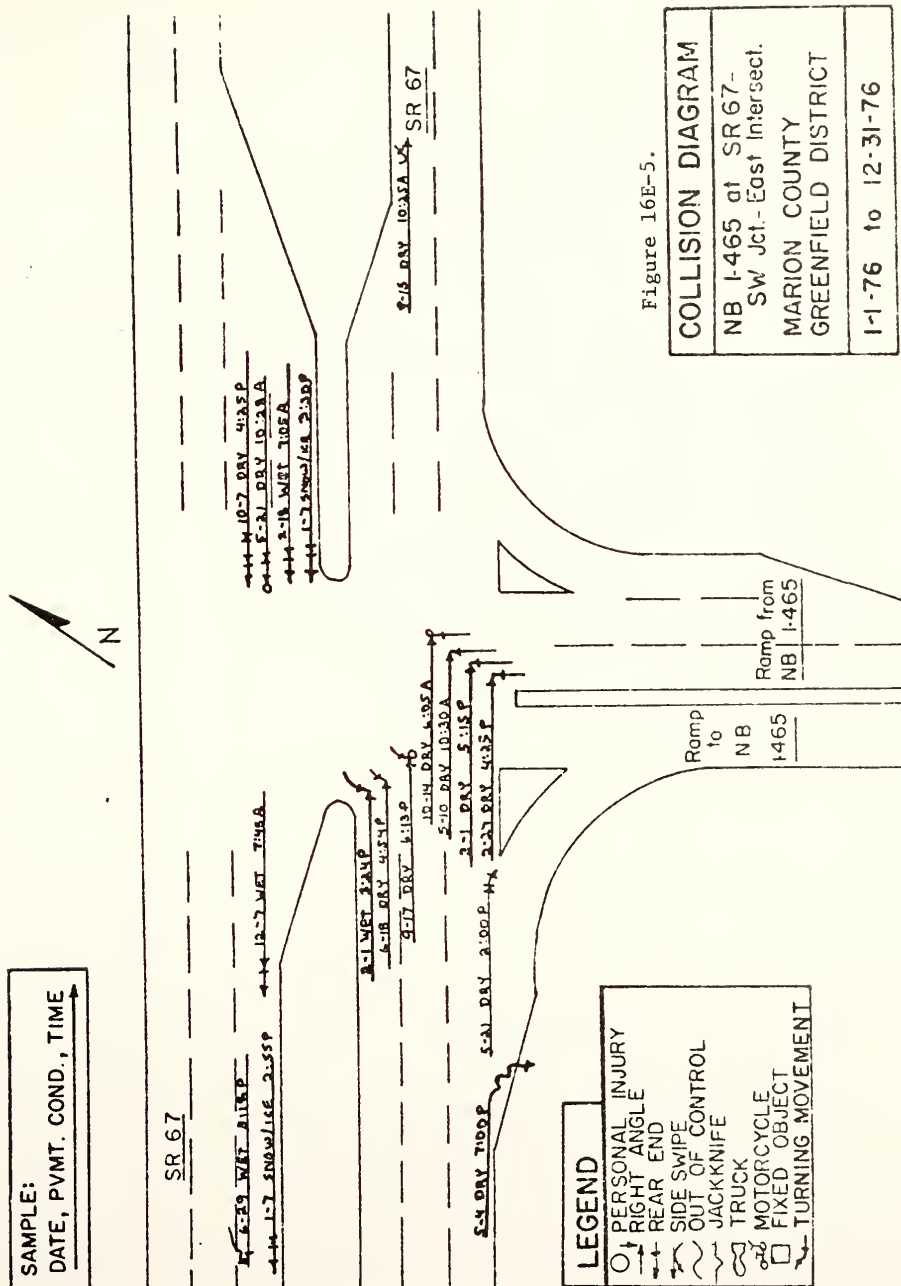


Table 16E-1.

ACCIDENT

SUMMARY

LOCATION: N-Bound I-465 at SR 67 - SW Junction -
E intersection of the interchange
Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
11	11	

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
5	6		6	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
	6	1	L= 3 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
8	1	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
	2	2		3	2	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									2	2			4
PM		1	2	2	2								7

Table 16E-2.

ACCIDENT

SUMMARY

LOCATION:		N-Bound I-465 at SR 67 - SW Junction - E. intersection of the interchange Marion County									
PERIOD:		1-1-75 to 12-31-75									
DISTRICT:		Greenfield									

TOTAL ACCIDENTS	DAY	DARK
	9	8

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
5	4		12	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
1	4	1	L= 3 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
5	2	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1	2		1	2		3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM										2			2
PM		2		1	2	1			1				7

Table 16E-3.

ACCIDENT

SUMMARY

LOCATION: N-Bound I-465 at SR 67 - SW Junction -
E. intersection of the interchange
Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS
17

DAY	DARK
16	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
3	14		4	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
7	4		L= 3 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
11	4	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1	2	3	4	2	5	

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM							1	2			3		6
PM			2	2	3	2	1	1					11

Table 16E-4. Stop Delay per Vehicle, Number of Conflicts, and Left Turn Conflicts for Existing Condition and Two Suggested Countermeasures at S.R. 67 at I-465 SW (East Intersection)

Countermeasure	Stop Delay Per Vehicle (seconds)	Rear End and Right Angle Conflicts	Left-Turn Conflicts
Existing Condition	34.86	26	64
Advance Warning System	28.35	16	64
Speed Enforcement on S.R. 67	38.19	23	63

SITE NO. 16W

Southwest Junction of S.R. 67 and I-465,
West Intersection

Description of the West Intersection, Southwest Junction,
of S.R. 67 and I-465

The west intersection at the southwest junction of S.R. 67 and I-465 is the intersection of S.R. 67 and the on and off ramps from southbound I-465 located in Marion County in the Greenfield district of the Indiana State Highway Commission. S.R. 67 at the intersection is a six-lane divided highway with left and right turn lanes to the I-465 on ramp. The off-ramp is two lanes with an additional right turn lane controlled by a yield sign. The intersection is controlled by an actuated traffic signal.

The traffic volume on S.R. 67 is approximately 11000-13000 vehicles per day in each direction, with approximately 6000 vehicles per day using the I-465 off-ramp. Approximately 2600 vehicles per day make turning movements onto the I-465 on-ramp.

The accident history at the intersection shows a total of 55 accidents during the three year study period, including 31 personal injuries.

Evaluation of the Intersection

The evaluation of the intersection was made by an analysis of the written comments of the investigative team members, with a consensus drawn from the comments.

Predominant Accident Type - Right Angle

Primary Cause - Motorists on S.R. 67 disregarding traffic signal.

Consensus Countermeasure - Provide additional signal heads and additional advance warning.

Other Possible Causes - Insufficient intersection clearance time, signal cycle length too short.

Other Possible Countermeasures - Increase amber signal phase and/or add an all-red phase, increase total cycle length.

Other Accident Types - Rearend

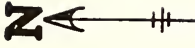
Possible Causes - Excessive speed on S.R. 67.

Possible Countermeasures - Reduce the speed limit on S.R. 67, increase the amber signal phase, add a strobe light to the red signal.

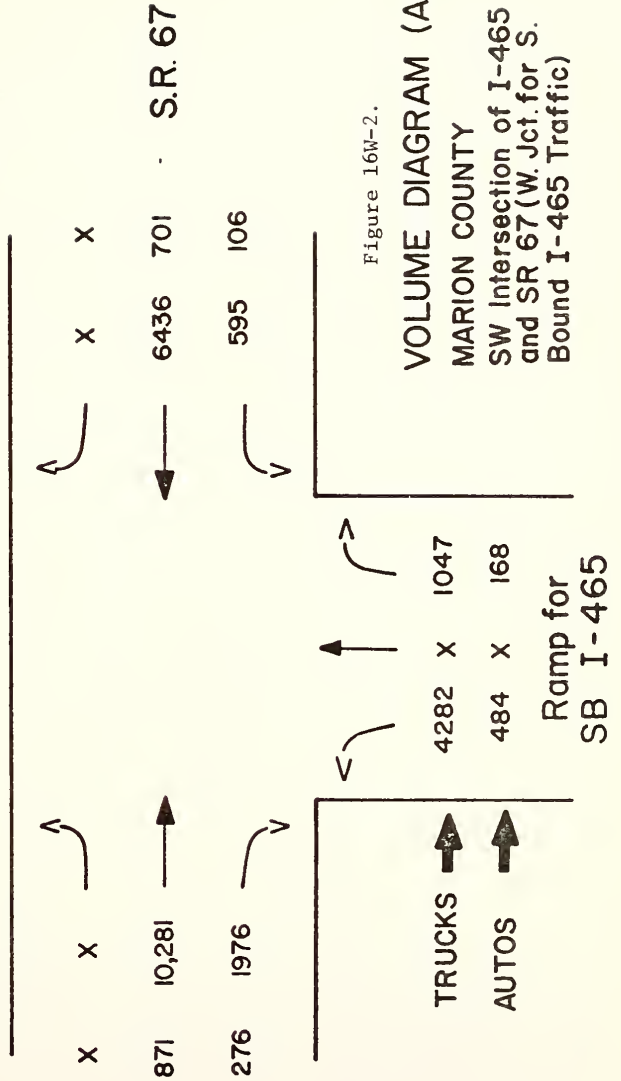
As in the case of the east intersection, the west intersection of the southwest junction of S.R. 67 and I-465 was also tested through the computer simulation model for two countermeasures, installation of an advance warning system and a reduction of speed limit on S.R. 67. Both of these countermeasures indicated reduction in right angle and rearend conflicts almost identical to the results at site 16E (see Table 16E-4).

Conclusion

Both right angle accidents and rearend accidents are a serious problem at this intersection, indicating that S.R. 67 vehicles are travelling too fast for conditions. Our recommendations are to provide additional advance warning signs on the S.R. 67 approaches, and to reduce the speed limit for both northbound and southbound S.R. 67 traffic well in advance of the intersection.



NOTE: THESE VOLUMES
ARE PROJECTED 1977
ADTS.



SAMPLE:

DATE, PAVT. COND., TIME

SR 67

E. 8-23 DRY 3:41P

W. 9-12 DRY 11:37P

SR 67

10-11 DRY 6:50P

7-13 DRY 11:27A

7-23 DRY 10:00A

8-24 DRY 11:57A

10-6 WET 11:55A

7-4 WET 11:50A

7-2 DRY 7:47A

6-11 DRY 7:15A

8-14 WET 4:00P

9-20 WET 4:41A

1-22 DRY 4:40P

LEGEND

- O PERSONAL INJURY
- ↓ RIGHT ANGLE
- ↖ REAR END
- ↗ TURNING MOVEMENT
- ~ SIDE SWIPE
- ~ JACKKNIFE
- ~ OUT OF CONTROL
- ☐ TRUCK

Figure 16W-3.

COLLISION DIAGRAM	
SB 1-465 at SR 67 -	
SW Jct. - West Intersect.	
MARION COUNTY	
GREENFIELD DISTRICT	
1-1-74	to 12-31-74

Ramp from
SB 1465Ramp
to
SB
1465



SAMPLE:
DATE, PVMT. COND., TIME

SR 67

5-4 DRY 2:05P
9-9 DRY 11:20P
9-11 WET 11:35P

2-28 DRY 12:30P H+O 7-3 DRY 4:55P 5-20 DRY 9:44A H+O
2-21 DRY 11:13P H+O 7-3 DRY 2:30P H+O 10-11 DRY 10:00P
9-29 DRY 6:30A 9-11 DRY 10:58A
10-5 WET 5:58A 11-21 WET 10:30A 2-23 WET 4:30P
3-12 DRY 1:30P
9-11 WET 6:32P

SR 67

LEGEND

PERSONAL INJURY
RIGHT ANGLE
REAR END
TURNING MOVEMENT
SIDE SWIPE
JACKKNIFE
OUT OF CONTROL
TRUCK

Figure 16W-4.

COLLISION DIAGRAM

SB I-465 at SR 67 -
SW Jct - West Intersect.
MARION COUNTY
GREENFIELD DISTRICT

1-1-75 to 12-31-75

Ramp
to
SB
I-465

Ramp from
SB I-465

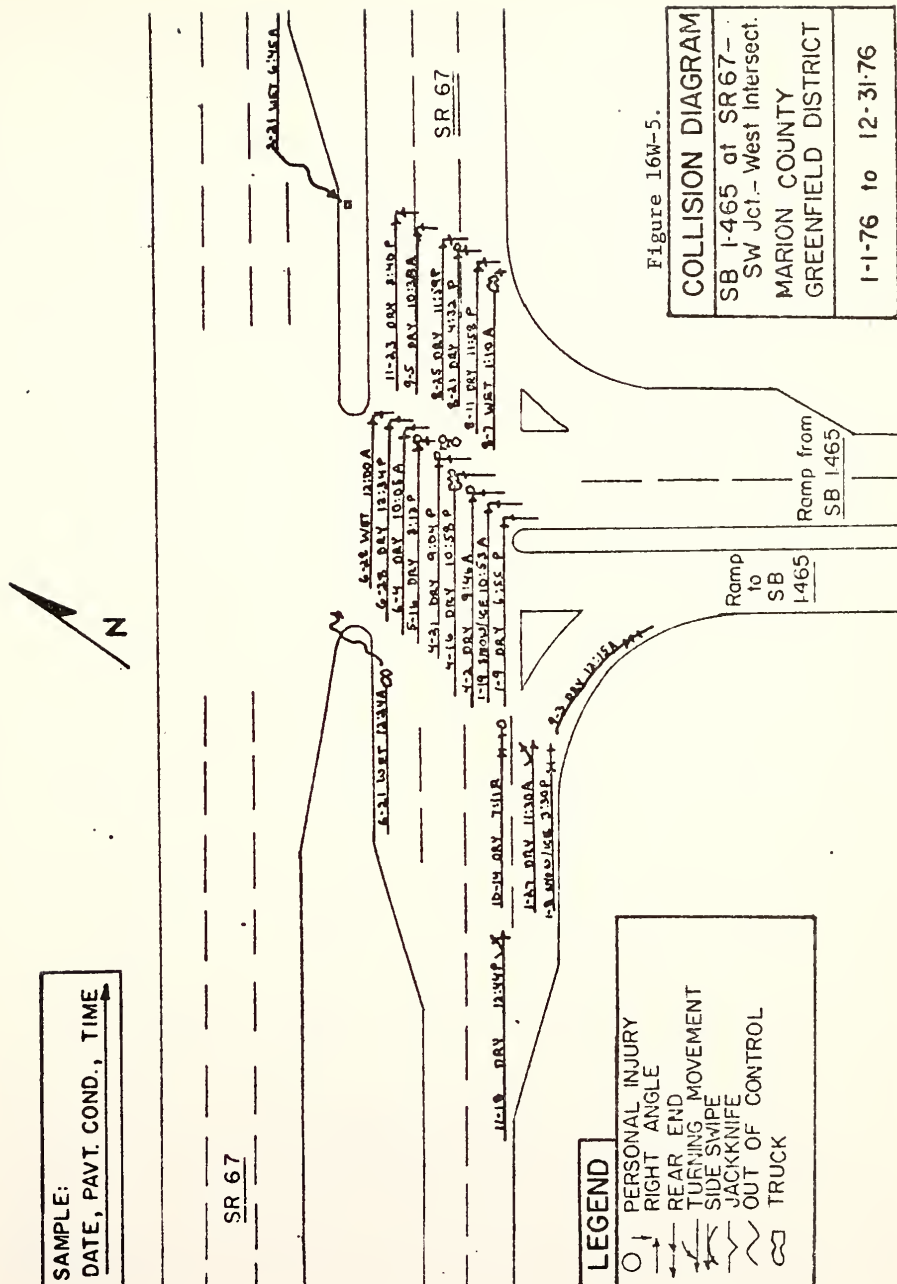


Table 16W-1.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - SW Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS
16

DAY	DARK
11	5

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
4	12		9	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	6	2	L= 1 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
2			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
10	5	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	2	4	2	1	3	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1						1	2			1	2	7
PM		1		3	2		1					2	9

Table 16W-2.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - SW Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS
17

DAY	DARK
12	5

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
6	11		14	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
12	4		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
12	5		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
	3	3	2	4	1	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM						1			1	1	2		5
PM	1	1	2	1	1	1	1				1	3	12

Table 16W-3.

ACCIDENT

SUMMARY

LOCATION: S-Bound I-465 at SR 67 - SW Junction -
W. intersection of the interchange
Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
22	11	11

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
6	16		8	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
3	15	2	L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
2			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
16	4	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	4	2	3	3	5	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	3	1					1	1		1	4	1	12
PM	2			3	1		1			1		2	10

Summary

The accident histories for the eighteen intersections were analyzed together with the recommended countermeasures to develop priorities for implementation of the countermeasures indicated. Following is a listing of the intersections in order of their suggested priority for improvement with a brief summary of the recommended countermeasure for each:

<u>Intersection</u>	<u>Countermeasure</u>
1. S.R. 67 and Franklin Road	Install overhead advance warning signs with flashers on all approaches, conduct signal timing study.
2. U.S. 41 and 45th Avenue	Install traffic signals in a box configuration, provide overhead advance warning signs on U.S. 41, and install advance warning signs on 45th Avenue.
3. U.S. 31 and National Avenue	Install overhead signs on U.S. 31 with lane use designations, conduct signal timing study.
4. U.S. 31 and Kern Road	Install overhead advance warning signs with flashers on U.S. 31, add left-turn phase to traffic signal for northbound U.S. 31 traffic.
5. S.R. 37 and S.R. 48	Provide all-red clearance phase in traffic signal, install strobe light in the red signals in all directions, conduct signal-timing study.
6. S.R. 37 and S.R. 252	Install flashers on advance warning signs on S.R. 37, provide all-red clearance phase in the signal.
7. S.R. 67 and I-465, West Intersection, Northeast Junction	Install near right traffic signals, monitor future accidents.
8. S.R. 67 and I-465, West Intersection, Southwest Junction	Provide additional advance warning signs on S.R. 67, reduce speed limit on S.R. 67.

<u>Intersection</u>	<u>Countermeasure</u>
9. S.R. 67 and I-465, East Intersection, Southwest Junction	Provide additional advance warning signs on S.R. 67, reduce speed limit on S.R. 67.
10. U.S. 31 and S.R. 38	Increase the advance warning distance on U.S. 31, install strobe lights on the U.S. 31 advance warning signs.
11. U.S. 31 and S.R. 18	Increase the size of the median stop sign, enforce the stopping maneuver.
12. S.R. 39 and S.R. 67, South Junction	Add a strobe light to the advance warning signs on S.R. 67.
13. U.S. 31 and S.R. 14	Add flashers with a strobe light to the southbound U.S. 31 advance warning sign.
14. S.R. 63 and S.R. 163	Relocate the flashers over the lanes, and increase the bulb wattage in the flashers.
15. U.S. 24 Bypass and S.R. 5	Install advance warning signs on all approaches, install a strobe light in the red signal on U.S. 24 Bypass, conduct a signal-timing study.
16. U.S. 40 and Round Barn Road	Provide left-turn lanes on U.S. 40, provide left-turn phase in the signal for U.S. 40 traffic.
17. S.R. 37 and S.R. 450	Monitor future accidents.
18. S.R. 67 and I-465, East Intersection, Northeast Junction	Monitor future accidents.

Bibliography

1. Ogren, James R., "A Multidisciplinary Team Study of High Accident Locations", Interim Report, Joint Highway Research Project, Purdue University, Report FHWA/IN/JHRP-78/18, October, 1978.
2. Radwan, Ahmed E., Sinha, K. C., and Michael, H. L., "Development and Use of a Computer Simulation Model for the Evaluation of Design and Control Alternatives for Intersections of Minor Roads With Multi-Lane Rural Highways", Joint Highway Research Project, Purdue University:
 - a. "Selection of the Model", Report FHWA/IN/JHRP-79/8, July 1979.
 - b. "Field Studies and Model Validation", Report FHWA/IN/JHRP-79/9, May 1979.
 - c. "Model Application", Report FHWA/IN/JHRP-79/10, July 1979.
3. Van Maren, Peter A., "Correlation of Design and Control Characteristics with Accidents at Rural Multi-Lane Highway Intersections", Interim Report, Joint Highway Research Project, Purdue University, Report FHWA/IN/JHRP-77/22, December 1977.

COVER DESIGN BY ALDO GIORGINI